MATERIALS & METHODS

THE METALWORKING INDUSTRIES' ENGINEERING MAGAZINE

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Super Alloys for High Temperature Service

Chromium-Vanadium Carburizing Steel "6120"

Continuous Casting of Alloy Bearing Strip

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Heat-Treated Rivets for High Strength Joints

Welding Multi-Layer Vessels

A Simple, Fast Metallographic Polishing Method

Processing Equipment for Peacetime Production

—MATERIALS & METHODS Manual No. 16

JUNE 1946

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are still in service

A steel furnace is a proving ground where the ability of a refractory to stand up under severe service is truly evident.

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R-237

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METALS and ALLOYS

MATERIALS & METHODS

THE METALWORKING INDUSTRIES' ENGINEERING MAGAZINE

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Cover Illustration: Since some large parts require the precision and surface smoothness of smaller components, special methods of lapping are employed, as in this scene in a Westinghouse Electric Corp. plant.

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RP REINHOLD

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Wherever electrical wire and cable demand the utmost in protection—there's a job for Saran (pronounced Sah-*ran*).

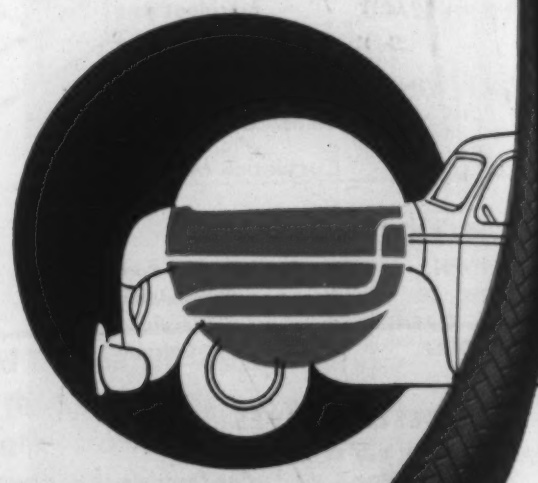
Braid, woven from Saran, a Dow plastic, cuts replacement costs because its toughness resists all forms of damage longer than most cable coverings. It's insurance against rot. It's fungus and mildew proof. It does not absorb moisture and oil—an important quality in such applications as automobile wiring. It's unaffected by a wide range of temperatures. And it resists abrasion far beyond requirements of most jobs.

These characteristics give Saran braid first call for hundreds of applications. Saran braid is new, but it's proving a big advance in wire protection —in simple jobs like telephone and extension cords and in complex radio and radar installations.

Any Dow sales office can tell you how Saran braid will cut down your electrical wiring troubles—and operating costs, too!

Saran braid's flexibility and wearing quality recommend it for telephone cords.

Rough use given such items as extension cords calls especially for Saran braid.



Saran braid protects wiring against oil, moisture and temperature extremes.

PRESENT AND POTENTIAL USES: Braided covering for wire and cable of all kinds. Especially valuable in guarding against abrasion in such applications as extension cords, etc. Many uses for cable such as household appliance cord that is exposed to moisture and consequent rendering of shock. Resistant to rot caused by entrapped moisture or oil in such applications as automotive wiring.

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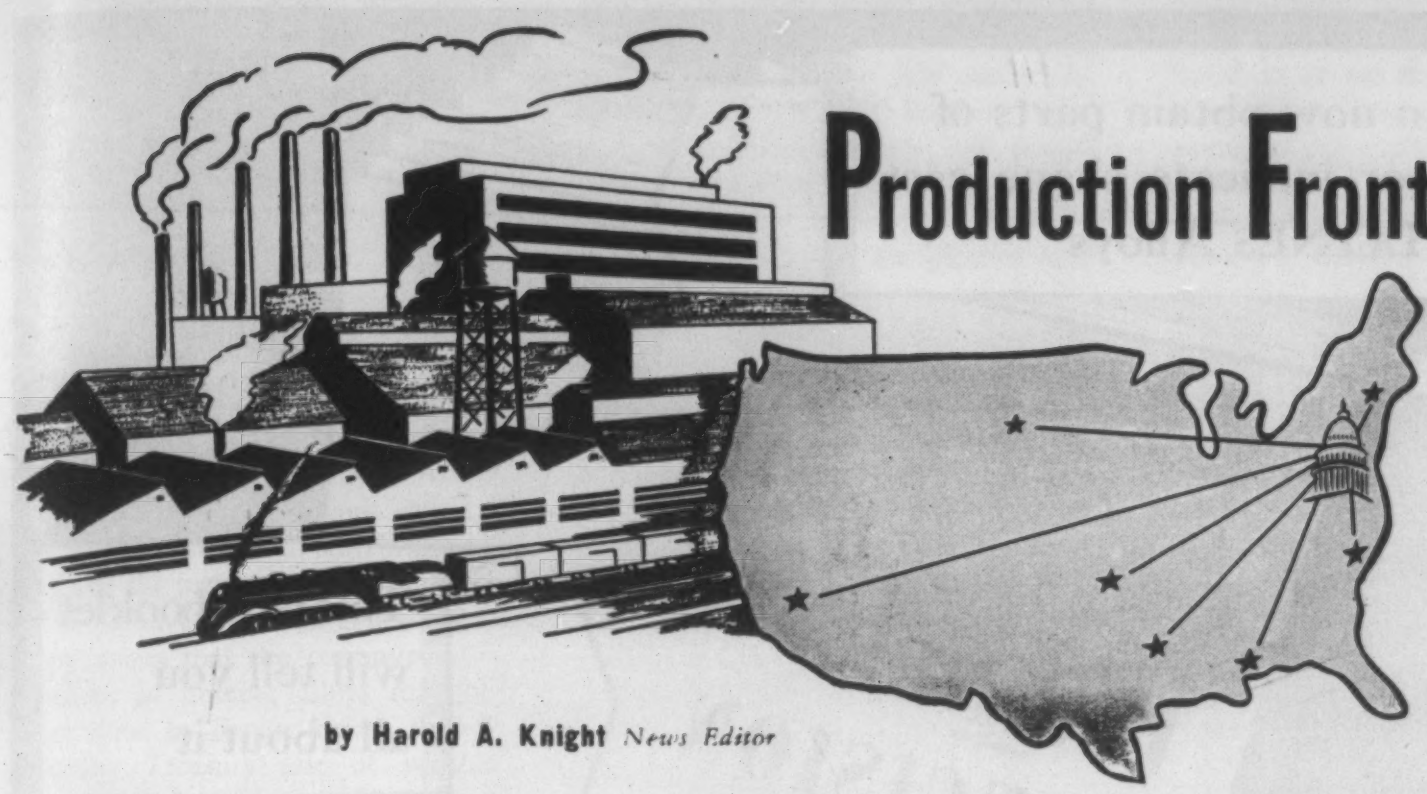


Production Frontiers

by **Harold A. Knight** *News Editor*

We Sniff for Prevailing Trends in Washington

The graceful deer poised at eventide and extended her delicate nostrils towards the rainbow-hued sunset. So would the writer of pretty little fantasies express it. Emulating the deer, in our own awkward way, we hied ourself to Washington. We, too, poised ourselves at the crossroads of Government and extended the nostrils of our "nose for news" in the various directions of rapidly shifting breezes.

Methinks we scented a new feeling of optimism and progress among those who head departments—or did the smell of spring blossoms in Washington's balmy air misguide us? Where our public servants had seemed confused and pessimistic before, they were more cocksure and cheerful. All this despite the devastating effects of the coal strike and lack of harmony with a certain big foreign power.

Thus, the home building program for veterans is more hopeful. Our "starts" in new building are running ahead of schedule. Makers of prefabricated houses have applied for priority assistance on 150,000 houses, and Washington expects to find materials for at least half of these this quarter year. OPA has granted higher price ceilings on several building materials, which should stimulate production. In fact, "the materials situation looks lots better", one member of the National Housing Agency insisted.

Government controls on cutting of timber are being lifted temporarily, with no longer insistence that cut of timber merely keep pace with new growth. "I'm bullish on the building situation after an extensive field trip", this official stated.

Then, again, surplus war goods are finally getting into the hands of the public, with veterans acquiring at least 40%. November sales were 150 million dollars in value; December, 210 million, January 300, February 400, and March 500. At this rate all will have been passed out by 1948.

Again, there is more confidence in our ability to compete with the rest of the world despite our high production costs, including high wages. One manufacturer states: "We can beat the Japs at their own game—even if they did not pay their employees a cent for their labor".

There is optimism in Export-Import bank circles, it being felt that this time we have loaned to other countries sanely and not in a grandiose speculative manner, as after the first war. There is confidence that our loans will be paid back many times because of stimulated foreign trade. "England grew great by foreign lending".

Labor Approaches Adulthood

There is more optimism as to the labor situation, it being believed that labor begins to see the folly of its ways. As one senator expressed it: "Let labor itself suggest and solve cures for troubles they know exist in their own ranks".

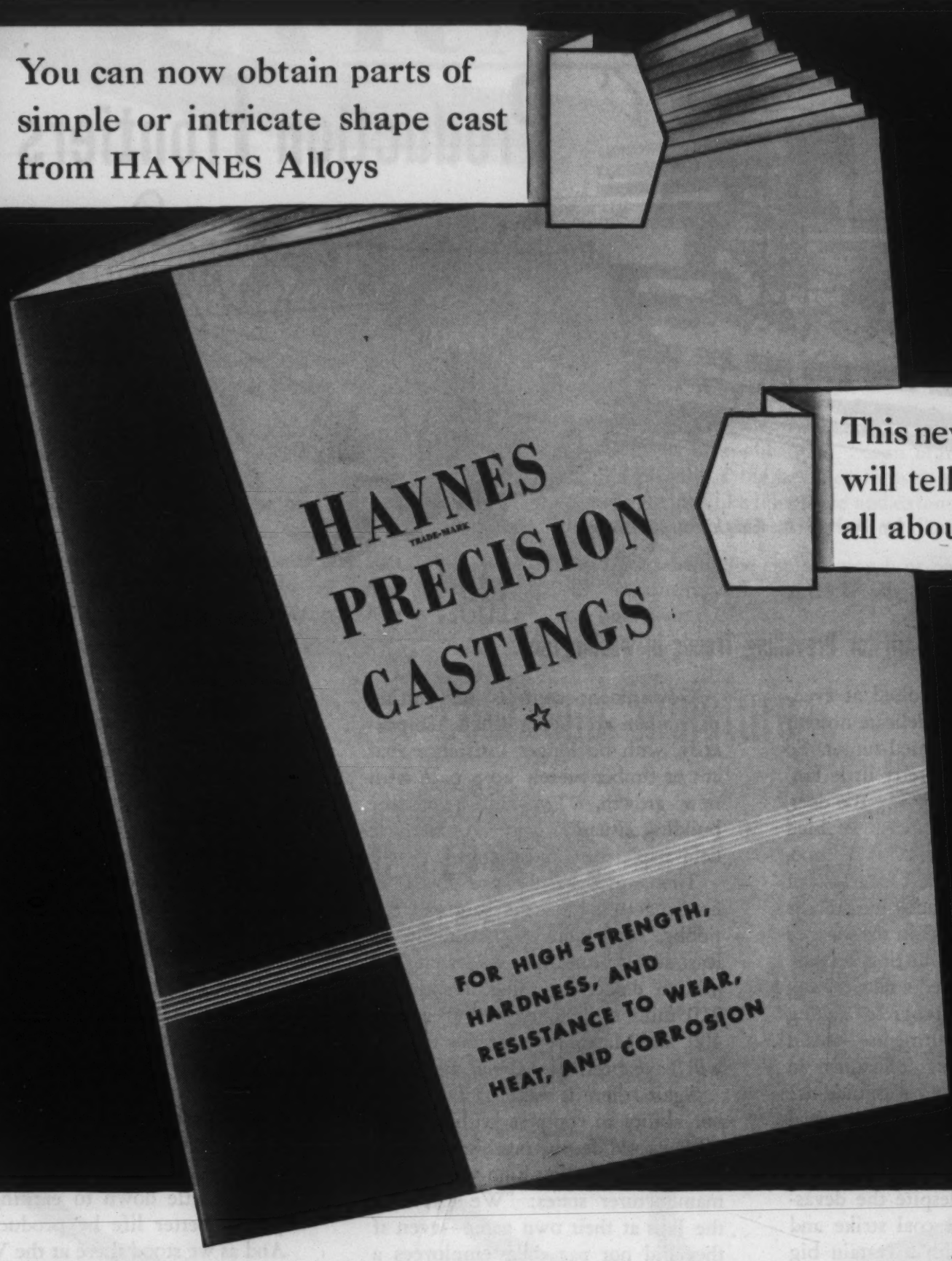
This senator apparently agreed with Paul Hunter, of *Liberty Magazine,* who wrote, when commenting on the General Motors strike: "There will be a marked lessening of arrogance among the tough guys of labor. They have discovered to their surprise that it *can* happen here. Instead of costly strikes, we will see a growing realization among workingmen and their employers that their aims are identical—more production and thus a better standard of living for all concerned.

"A billion dollars is a lot to lose, but it is cheap if thereby we discover this early in the postwar era just how far it is possible to get by demanding, and settle down to earning our way to a better life by production".

And as we stood there at the Washington crossroads, with nostrils distended, we scented a growing dissatisfaction on the part of industry against controls. "Let's return as rapidly as feasible to free competition" was the universal cry.

"With more than 800 strikes scheduled, it is time to end government intervention in industrial relations and bring about free and equal collective bargaining", stated M. M. Anderson, vice president, Aluminum Co. of America. "Too often government intervention is for political expediency and not directed toward helpful solutions."

You can now obtain parts of simple or intricate shape cast from HAYNES Alloys



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This new 20-page booklet describes the HAYNES precision casting process, and contains photographs and drawings of parts produced by this method. Mail your request to Haynes Stellite Company, Department E, Kokomo, Indiana.

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Lead Industries Assn. asks for: (1) Return to a free market for lead, (2) elimination of subsidies (or premiums) to both foreign and domestic lead producers, and (3) removal of Government as the sole buyer of lead imports and removal of government limitations on imports. Spokesmen for the American Zinc Institute ask for removal of subsidies and raising of price ceilings for zinc. "It is worthy of note that the British Government in the last few days has increased the price ceilings of zinc and other nonferrous metals, stating that the purpose was to shift the load from the tax payer to the consumer."

The Silver Users' Emergency Committee states that the continued use of silver in brazing alloys may be jeopardized by Senate delays in authorizing Treasury sale of surplus silver for industrial uses. The silver supply for industry has varied from 30% of the volume needed in January to under 5% in April, the committee claims.

Gay and Gaudy Plastics Show

Gay, gaudy and carnival-like—that's the way one of our editors describes the first National Plastics Exposition at the Grand Central Palace, New York, in late April. About 87,000 persons visited the exposition during its six days. Though large, it did not compare in size with last February's Metal Show in Cleveland.

The show was theoretically open to "the trade" the first three days and to the public (at $1.00 plus tax) the last three days. But some cynic observed that the public outnumbered the trade 2 to 1 during the first half and vice versa the last three days—such is the curbing power of $1.10 admission fees.

Yes, indeed, "gay, gaudy and carnival-like"—but this is no condemnation. The glamour of plastics made it the most interesting show that seasoned exposition-goers have experienced. Of course, industrial exhibitors and their friends were heavily outnumbered by consumer retailers and the public. From the industrial standpoint, the oustanding trend in plastics is the growing importance and utility of "structural" plastics—those used because of mechanical strength, toughness, formability, etc.

To the technical men of prime importance was the Society of the Plastics Industry annual conference. A highlight was an unusually thorough analysis of the raw materials situation by W. S. Landes, vice president, Celanese Corp., and president of the Plastic Materials Manufacturing Assn.

Now the demand for plastics raw materials is ahead of the supply by 3 to 1, despite the fact that the total production of plastics for all uses (including coatings and adhesives) is double the 1941 volume, and the total production of plastics just for *molding* is in a 5 to 3 ratio with 1941. This is a distressing situation for which no relief is visible this year and perhaps not until late in 1947, and it is far and away the biggest problem facing the industry today.

"I'm sorry, Mr. Smythe, but we can't consider the fact that you picked her up with a plastic whistle a MATERIALS & METHODS *Achievement!"*

By "demand" is meant the pressure of orders on the materials manufacturers. Another way of measuring demand is by installed machinery capacity of the molding and fabricating plants. During the war the molders and fabricators installed machinery at a tremendous rate until today the capacity of such machinery in terms of the materials it can process stands in a 2.6 to 1 ratio with available raw materials.

While the fabricators and molders could get new machines, the raw material manufacturers could not, and although the raw material manufacturers' projected expansions will increase their total capacity another 50% by mid 1947, it will still fall far short of the demand as currently measured. Furthermore, the new housing program of the National Government, which has virtually outlawed industrial building, puts a complete damper on any plans for additional factory expansion unless the Government can be made to see that plastics materials and products for low cost houses will be unavailable unless the plastic materials manufacturers are authorized to expand their manufacturing capacity.

Among the plastics fabricating processes, the greatest expansion has been in injection molding and extruding. Among the materials the celluloses, polystyrenes and acrylics have made the most spectacular application gains in terms of percentages of their own volume.

As to the future: Last year the total production of plastics materials mounted to 900 million lb.; in 1947 it will be more than 1 billion lb. One authoritative prediction is that the industry will double itself during the next five years and redouble that volume during the succeeding five years—in other words, that total production of plastics will be more than 3.5 billion lb. by 1955. If this be true we must soon stop speaking of plastics in terms of pounds and use tonnage figures.

But to get back to the exposition—one of the exhibits was not truly an exhibit but real production. Plastic Molded Art in the Reed-Prentice booth had a big order to fill, banging out pocketbook squares. The attending public thought these eager beavers were merely putting on a show. For the workers it was just another day at union pay.

Then, perhaps, you saw the plastic clutching hand (belonging doubtless to a person with an "evil eye"). Made of plastic, it was terrifically realistic. Extending through a wall it slowly opened and closed. A group of gay old gals walked by. "Maizie, I challenge you to touch it". Maizie did, followed by hysterical shrieks—all like commotion in a hen house when a weasel has entered.

There was a plastic trombone, called Toot-a-Tone, that Tommy Dorsey might like to play; an illuminated plastic garden hose through which water was running; there were balls for bearings made by Bakelite; a baby carriage with body of plastics;

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Where weather resistance in service is desirable, fabricators prefer Sharon Galvanite. It is a hot dip zinc coated strip that provides the maximum protection against rust.

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a machine making gayly-colored combs while you waited; compression molding machines making blue liquor jiggers or cups and passed out to the audience; a dress made of Saran yarn, washed with a wet sponge; and one peeked through magnifying glasses to see various glues doing their binding stuff.

Metal Powders: Britain and Here

There has been no real fundamental research in powder metallurgy in England though the powder metallurgists have benefited from analogous research in related fields. Prior to World War II the bronzing or painting pigment powder made up the bulk of British metal powder production. There was neither ferrous, copper nor alloy powder (save Permalloy) made there, all materials being imported from America, Germany and Sweden.

These and other interesting sidelights on British powder metallurgy have been given by Dr. W. D. Jones, author of the pioneering English language text on this subject. During the war British aluminum powder capacity was expanded, mostly for incendiaries. By the end of the war output of zinc for metal spraying was 15 tons weekly. They learned to make electrolytic copper powder; they have two processes for electrolytic iron, but output is small. They could not devise a good substitute for Swedish sponge iron powder (though Americans did).

England did not go in for machinery and ordnance parts of powders, as did the United States, due to shortage of materials and skilled personnel. However, they did make these standard products: Porous bronze bearings (they also made steel-backed copper-lead bearings by powder metallurgy methods), tungsten carbide bullet cores and heavy alloy parts.

Among the novel items were piston rings for high compression motors; finished parts of various types, made by spraying molten metal powders on to molds or forms; porous tungsten carbide dies to be used for powder metallurgy pressing, which enjoyed the self-lubricating advantage; de-icing strips, which consisted of a sintered porous copper-nickel strip embedded in a channel along the leading edge of the aircraft, with the de-icing fluid exuding from the pores at a controlled rate under pressure from a small pump that is part of each de-icing system.

The trend in England will be for "specialty" products, or those which cannot be made by other methods. Thus, for certain electronics raw materials and parts, powder metallurgy is the only practical process. Application of powders to machinery parts on a competitive level with other processes will decline. The "specialty" angle, however, will be enhanced by new alloy powders, special compositions and metal-nonmetallic combinations.

To get back to the United States, many believe that we have overextended ourselves in powders for machinery parts and that our future lies in specialty items. In that respect they agree with Dr. Jones in his predictions for British trends.

New Thoughts on Atomic Power

Before 1939 uranium was an almost useless by-product in the recovery of radium. In nature they occur in the constant ratio of one part of radium to 3,000,000 parts of uranium. At times both radium and uranium have been by-products from the production of metallurgical vanadium from American carnotite. Never before 1939 was there any large demand for uranium, and a considerable quantity had been accumulated in radium production, principally from the pitchblende ores of the Belgian Congo and of Great Bear Lake in the Northwest Territory of Canada, reported S. C. Lind, dean of the Institute of Technology, University of Minnesota, before the Electrochemical Society.

When the fission of uranium as a source of power and explosives was discovered early in 1939 relations changed almost overnight. Uranium became valuable beyond estimation, all known sources were brought under government control and a complete blackout of information enforced.

The use of radium in radiography may be replaced by some of the new fission products, provided that they emit gamma radiation of sufficient penetration. Most of these products are rather short-lived, and resources would be dependent on the continued operation of a fission pile for military, scientific or industrial purposes.

The new elements seem to offer little hope in the luminous field where alpha radiation is a requisite. Plutonium 238, made by deuterium bombardment, would probably be too expensive. Plutonium 239, made in a uranium pile, might not be too expensive. Its half life of 24,000 yr. is 15 times longer than that of radium, but it is that much less favorable in intensity. Also, plutonium emits only one set of alpha rays against radium's four. Thus, 60 times as much plutonium would be needed for equal luminosity with radium.

It is suggested that uranium may be a member of a new rare earth series beginning with actinium. Thorium, protactinium and uranium would then be the second, third and fourth members of the series. Uranium would then be placed below neodymium in the periodic table of elements, instead of below tungsten. Already we have neptunium and plutonium by neutron reaction on uranium and, recently, elements 95 and 96 by bombarding uranium and plutonium with 40,000,000 volt helium ions.

Under the heading of "Medical and Industrial Uses of Pile Products" in the *Bulletin of the Atomic Scientists* (of Chicago), it is stated that the prospects of large scale atomic power are of less immediate importance than production of radioactive substances in small piles. What is now performed with the cyclotron on a tiny scale could be done in much larger quantities with the chain reaction "pile".

Through these "piles" cures for diseases will be discovered more rapidly and new products and materials will be developed which may give rise to great new industries comparable with synthetic rubber, plastics and light metals. The radiations can be made available for controlled industrial use through ports cut in the concrete or steel shields. The radiation is emitted as a beam through these ports.

A portable provision would consist of radio-active materials formed in the pile, concentrated into a small bulk and shipped in suitable containers. In most cases these portable sources of beta and gamma rays will be convenient and adequate. Gamma-ray emitting materials may be used as cheap, portable sources of radiation for X-raying large pieces of metal and other opaque materials for flaw inspection. They may be used in automatic regulators to set off control mechanisms.

News of

Engineers — Companies — Societies

Engineers

Frederic W. Willard, president and director of the Nassau Smelting & Refining Co., Inc., and a metallurgist and chemical engineer of national prominence, retired April 30 after 40 years with the Bell System. He has been active in many technical societies, an author of numerous technical papers, and a member of National Research Council. He is succeeded by *William A. Scheuch*, vice president, who joined Bell as a metallurgist in 1916.

Russell Franks, chief metallurgist, Union Carbide & Carbon Research Laboratories, Inc., has been appointed to the Technical Service and Development Dept., Electro Metallurgical Co., another Union Carbide unit. He is a leading authority on stainless and heat-resisting steels, and has presented many technical papers on chromium alloy steels.

Lloyd Kramer has joined the Biad Powder Metallurgy Co. as metallurgist, while *George Pearlman* has joined Biad as production manager.

Lt.-Col. Norman A. Matthews, formerly at Watertown Arsenal, has become works metallurgist of Electro-Alloys Div., American Brake Shoe Co. Before the war he was with U. S. Steel. For ordnance work he was awarded the Legion of Merit decoration.

Don A. Lawless, materials engineer, specifications section, metallurgical department, Reynolds Metals Co., now heads a new Reynolds technical service department. He did work for the Navy during the war.

Francis M. Rich has been made vice president in charge of iron and steel operations at the Fontana, Calif. plant of Kaiser Co., Inc. He has received the *J. E. Johnson, Jr.* award of the mining and metallurgical engineers for blast furnace development. He has served a half-dozen steel companies in the past 20 years.

Captain Carl J. Lamb, who served the Navy for five years, has joined Hydropress, Inc. as vice president. He has had wide experience with electric-hydraulic mechanisms.

Homer W. Northrup, formerly with the melting department, Iron & Steel Foundry Div., Crane Co., has joined the technical section of International Nickel Co. to be associated with foundry activities at Chicago.

Torsten F. A. Edvar, formerly chief engineer, Harold E. Trent Co., Philadelphia, has joined the engineering staff of the Ajax Electric Co., same city.

Everett C. Gosnell, formerly manager, Chemical Div., Lukens Steel Co., has joined the Colonial Iron Works Co. as manager, Chemical & Process Equipment Div. He is an expert on corrosion problems, and belongs to several technical societies.

Robert S. Herwig heads the expanded plating department of the Bogue Electric Co., Paterson, N. J. He was previously supervisor of chemical research, Eclipse Pioneer Div. He has delivered many papers on plating and anodizing before technical societies.

Dr. Eugene P. Wigner, member of the Princeton University faculty and world authority on nuclear physics, has been made director of research and development for Monsanto Chemical Co's. Clinton Laboratories at Oak Ridge, Tenn. He was educated in Germany. *J. Kenneth Craver* of Monsanto has become coordinator of plasticizers and resins for the Organic Chemicals Div. of that company.

Companies

The *Reynolds Metals Co.* has arranged for a $12,500,000 loan from a banking syndicate to finance enlarged operations and provide additional working capital for the company's operation of government-owned aluminum plants, which it has leased, including those at Hurricane Creek, Ark., Troutdale, Ore., Jones Mills, Ark., and McCook, Ill.

A $650,000 iron powder plant will be built near Aurora, Minn., by *Continental Machines, Inc.,* Minneapolis. Its raw materials will be heretofore worthless Mesabi carbonate slate. The "Firth" process will be employed.

A record-breaking total of $327,000,000 for new equipment and alteration of steel plants is earmarked for 1946, states the *American Iron & Steel Institute.* The money will go largely for light steel production.

The *Aluminum Co. of America* will erect a 22-story office building at Park Ave. and 58th St., New York. It will be the first building in the world to use a new type of construction embodying an aluminum-faced curtain wall. The entire facade, except window areas, will be aluminum. Inside may be movable aluminum interior partitions.

Buick Motor Div. has started the greatest expansion and modernization program in its 40-year history. It has acquired 1,000,000 sq. ft. of additional floor space. The aluminum foundry, which made cylinder heads and blocks for fighting aircraft, will be converted into a machine shop.

The *American Car & Foundry Co.* has established a welded products division that will concentrate on the design, development and manufacture of weldments.

The *Wright Aeronautical Corp.* is selling its properties at Paterson, N. J., to the *Aero Holding Co. of New Jersey,* one of the largest real estate deals of its kind in that state. Wright is consolidating its facilities at Woodridge after having been at Paterson since 1919.

Charles Hardy, Inc. and the *Hardy Metallurgical Co.* have been merged into a single organization to operate as *Charles Hardy, Inc.* The new company has four divisions: metal, chemical, technical, and specialties.

The *National Radiator Co.* has bought the *Pullman-Standard Car Co.* plant at Middletown, Pa., where it will fabricate steel boilers, pressure vessels, heat exchangers and other industrial products.

A government-owned plant, built during the war by DPC for production of magnesium, has been leased by the *Southern Alkali Corp.* for production of caustic soda and liquid chlorine.

A new department of *Timken Roller Bearing Co.* has been announced, and one of the projects is a new method for making bearings metallurgically and geometrically more perfect.

The *Reading Div.* of *Atlantic Plastics, Inc.,* producer of Nylon and other specialized thermoplastics in the form of rods and heavy section moldings, now operates under the name of the *Polymer Corp.*

The *Ceco Steel Products Corp.* has bought eight acres of land from the Hermann Hospital estate in Houston and will erect a plant for fabrication of reinforcing bars, steel forms and steel joists.

Societies

The *American Foundrymen's Assn.* has announced a new medal, the Peter L. Simpson gold medal, awarded for the first time to Howard F. Taylor, formerly of Naval Research Laboratory and now research associate at Massachusetts Institute of Technology . . . A. M. Sargent, Pioneer Engineering Co., Detroit, was elected president of the *American Society of Tool Engineers* at its recent convention attended by 53,831 persons.

The feature of the meeting of the *Society for Experimental Stress Analysis* at Hotel Statler, Buffalo, June 24-26, will be a symposium on the fatigue of manufactured parts, under joint sponsorship with the *American Society for Testing Materials* . . . At the latest meeting of the *Acid Open Hearth Research Assn.* it was stated that work on low carbon heats has been completed and that the staff is now engaged in a new high carbon investigation.

Clarence W. Custer, American Stamping Co., has been elected president of the *Pressed Metal Institute* . . . The annual prize of $100 to young authors from the *Electrochemical Society* went to Dr. Austin E. Hardy, while the F. M. Turner prize of technical books ($50) went to Dr. James T. Waber . . . The University of Washington offers four fellowships to the College of Mines for research in coal and nonmetallics in cooperation with the *U. S. Bureau of Mines,* starting July 1.

Meetings and Expositions

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, semi-annual meeting. Detroit, Mich. June 17-20, 1946.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, applied mechanics division meeting. Buffalo, N. Y. June 21-22, 1946.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting. Buffalo, N. Y. June 24-28, 1946.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, corrosion conference. Gibson Island, Md. July 15-19, 1946.

INSTITUTE OF THE AERONAUTICAL SCIENCES, summer meeting. Los Angeles, Calif. July 18-19, 1946.

Editorial Comment

Shifting Costs of Engineering Materials

Not only do new processes and materials come along, and revival of old processes on more economic lines take place, but prices of raw materials fluctuate—all to harass the materials and design engineers when trying to choose a material on an economic basis. Particularly harrowing just now is the last feature, and it will require a prophet of the nth power to correctly size up these cost features over the next few months and years.

Take the question—whether to make it of copper or aluminum from the standpoint of costs of raw material. Price trends on aluminum tend to be downward, with the contrary on copper. Britain recently lowered its price on aluminum, as did Canada. American copper producers are asking for a revised ceiling of 15 cents per lb. as against a present 12 cent ceiling and an OPA proposal of 14 cents. A price change to either 14 or 15 cents would make copper plainly dearer than aluminum, which is now 14 to 15 cents, also with due consideration to difference in specific gravity.

One circumstance which will have tremendous impact on values has been the rapid depletion of our natural resources during the war. Lead, copper and zinc, three of our tightest metals just now, have changed in economic status tremendously since 1941. When ceilings are raised and artificial control is eliminated—say in 1947—prices of these metals are bound to make substantial gains.

Aluminum, on the other hand, has become a decidedly plentiful metal, at least compared with pre-war standards. In this class, too, is magnesium, whose supply from the sea is unlimited, as present promotion pieces for the industry insist.

Then, too, there must be considered the age of a process or material. Plastics, plywoods, glass and light metals, as we know them in present forms, are new, or infant, industries. It is almost unfailing experience that new products become cheaper as mass production techniques improve and expand. Hence, other things being equal, prices of these should tend to decline.

In conclusion, then, though it may be difficult to judge short term trends in costs of basic materials, there are certain lines of reasoning that can be pursued in ascertaining the broad picture and long term trends.

—H. A. K.

More About "Lost Knowledge"

Last month in our editorial, "Lost Knowledge", we estimated that at least one-third of the technical knowledge gained during the war might be lost. We based this partly on the observation that the technical information acquired has been poorly and incompletely recorded. We want to reinforce our estimate with another observation. This is it: Even if a perfect job of recording all the technical data had been done, another large obstacle would remain; that of properly cataloging and summarizing this huge mass of written material.

Accurate cataloging is necessary so that future seekers of the acquired knowledge will know what's available and where to find it. It is encouraging that some progress along these lines is being made by the Office of the Publication Board, Department of Commerce. This organization is in the process of microfilming and classifying the mountains of reports written during the emergency. Just how accurate and complete their work will be remains to be seen.

One further step is desirable. All the accumulated technical data should be reviewed by competent people, and summary reports written. These reports would be analytical digests of the work accomplished in each of the thousands of research and development programs. Thus, a series of documents would be created which would contain concise accounts of the war-time technical accomplishments for future reference. It would tie together a lot of loose ends and prevent the loss of much valuable information. Here, again, some progress has been made. The Ordnance Department has worked closely with industry in writing-up summary-reports, or "histories", on the production of some ordnance material such as armor and gun forgings. The Smyth report on atomic bomb production is another good beginning. It is very probable that more detailed summary reports on all phases of atom bomb production are in progress.

But these are only beginnings and a lot remains to be done. To summarize the detailed technical accomplishments in all fields is a tremendous undertaking. We admit frankly that we have no concrete suggestions as to how to do it. Maybe the technical societies should get together and work out a comprehensive plan; maybe it is solely a Government job; maybe it's an impossible job.

Impossible or not, we still think the job should be done.

—H. R. C.

Alloy Steels Last Year

Some rather interesting and significant facts can be gleaned from a recent statement of the American Iron and Steel Institute covering the preliminary statistics of the 1945 production of alloy steels.

Despite the ending of hostilities in mid-1945 and a consequent let-down in the war demand for these steels, last year's output of about 8,613,000 net tons was 11% of the country's total steel production, or only a little less than the 12% in 1944. This indicates that the demand for alloy steel was at a high level last year. It is interesting to note also that the indicated 1945 alloy steel total was more than double the output in either 1937 or 1939.

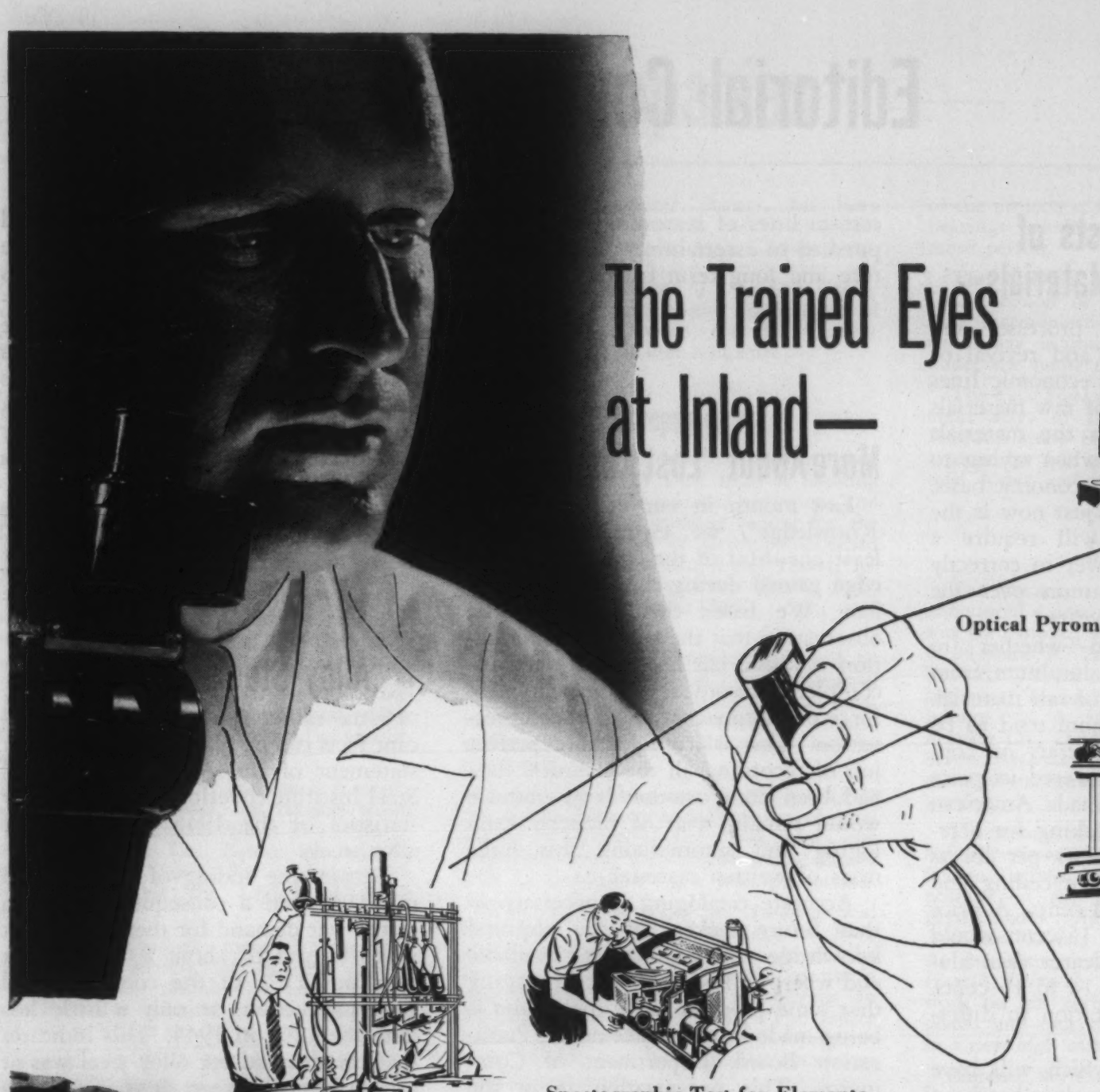
One significant record was made last year. It was in stainless steel. For the first time the country's total exceeded the 500,000-ton mark at approximately 540,000 tons. It was 477,498 tons in 1944. This increased demand for these high-grade steels was not due entirely to the war; it rather signifies expanding post-war applications.

The Institute's statement calls attention to another trend which is of decided importance. Last year approximately 67.5% of alloy steels was made in open-hearth furnaces. This contrasts with 66% in 1944. This trend is of marked interest to the electric furnace steel operators. If this means that the open-hearth process is gradually gaining on the electric in the production of alloy steels, it will make the problem of the use of the present large electric furnace capacity of the country a still more difficult one.

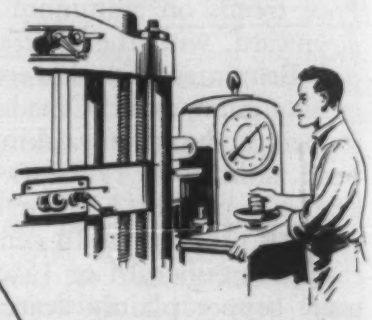
One inference from these trends is that the future of alloy steels is definitely bright.

—E. F. C.

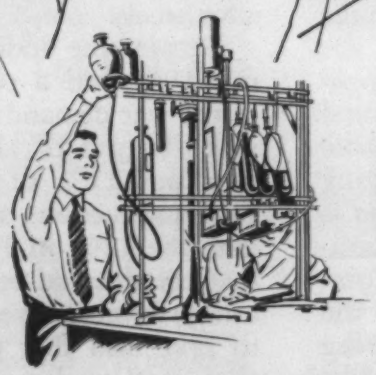
The Trained Eyes at Inland—



Optical Pyrometer Temperature Testing



Tensile Strength Testing



Chemical Analyses Testing

Spectographic Test for Elements

Every day, year in and year out, ton after ton of steel passes the scrutiny of Inland's "trained eyes" . . . Samples are gathered from all operations and subjected to exacting tests before the steel is permitted to be rolled into final form.

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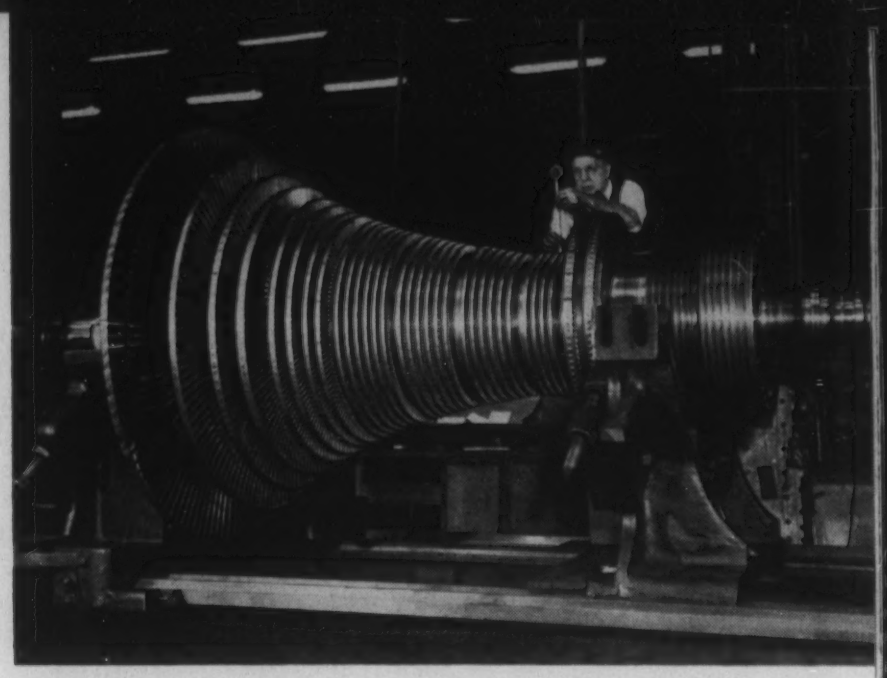


Super alloys are finding wide use in turbines. Shown is a 20,000-kw. turbine spindle mounted in a lathe. (Courtesy: Westinghouse Electric Corp.)

Super Alloys for High Temperature Service

by HAROLD A. KNIGHT, *News Editor,* MATERIALS & METHODS

AT LEAST 40 HIGH TEMPERATURE alloys have been used since our entry into World War II, of which at least 35 were designed to stand temperatures of 1200 to 1600 F, the other five or so alloys being used in parts somewhat removed from the most severe heat zones. From a tonnage standpoint the bulk of our high temperature metals, or "super alloys," entered production of turbosuperchargers whose function was to compress atmosphere at the rareified levels of 30,000 or more feet and feed it into the airplane's motors. Thus a supercharger recovers for a 1200-hp. engine the 920 hp. it would otherwise lose at 34,000 ft. altitude.

It was not a drastic step from manufacture of turbosuperchargers to aircraft jet engines, at least from standpoint of design and choice of high temperature alloys. However, it was a much tougher job. Take the I-40, G. E. jet engine that powered the P-80 "Shooting Star," three of which made history by flying across the continent last winter in record time. The weight of the turbine wheel or disk rose from 15 lb. to 198 lb. Larger hammers and presses were necessary. Drop-forging hammers had to be enlarged to handle the job. Thus one 35,000-lb. hammer was remodeled to 47,500 lbs.

Side by side in development with turbosuperchargers and jet engines has been that of steam turbines and more particularly gas turbines for stationary power or heavy mobile power equipment. Thus from the highly satisfactory experiments now being conducted at the Naval Experiment Station by Allis-Chalmers and the Navy it is estimated that an overall plant thermal efficiency of 40% at 1500 F could be obtained with a modified gas turbine plant for marine application, compared with 25% for an average steam plant and 5 to 8% for reciprocating steam locomotives.

And, speaking of efficiency, two new types of jet aircraft engines weigh less than ½ lb. per 1 lb. of thrust, which is less than one half the weight of piston engines. The conventional plane, assuming 1 hp. equals 1 lb. of thrust, must spend one-third of its power to drag itself through the air. The gas turbine uses only 1/10 of its power against drag. These new engines are the smallest in size and weight for their power in the United States. The tip ends of their turbine blades are moving at 750 m.p.h., but even 10,000 r.p.m. is attained by the new Consolidated V-XP-81 (a combination of propjet and I-40 jet) and at a temperature of over 1500 F.

From a metallurgical standpoint the main problem was to find alloys that would withstand high heat and pressure without expanding and distorting, at least in the blades, or buckets—and wheels. In

This complete discussion is the first to list heat resistant materials developed for gas turbines and related uses and now available generally.

other parts of the jet engine or stationary or marine gas turbine expansion can be taken care of by special expansion joints. In the I-40 jet engine a piston and cylinder idea was incorporated into ducts and combustion chambers.

The Germans notoriously had a marked head start on us in jet propulsion. Lacking key critical metals they had to resort largely on design. Thus they used hollow buckets or blades both for lightness and to conduct air for cooling. They were lucky if the life of their jet engines reached 100 hr. The Germans experimented with fused quartz, aluminum oxide and different types of porcelain for high heat parts. Porcelain proved best in exploratory tests. They were working towards a ceramic that can be machined and is strong up to 1830 F. Dr. William F. Durand of the National Research Council has stated that a possibility for us is a ceramic coating on a metal turbine blade. The problem is to find a ceramic with sufficiently high melting point to bond with metal and with a coefficient of expansion near enough to metal to insure against cracking or flaking off over a wide temperature range.

It is well to point out here that profligate use of expensive and scarce metals during a war is not within the realm of economics. Where can the world get sufficient cobalt, for instance, to continue to use that metal in peace on the same scale as at war? Again as to columbium, used as a stabilizer of stainless steel, the Belgian Congo supplies practically were exhausted at times, necessitating the use of titanium. Hence there is a constant search in progress to find the more abundant and inexpensive alloy combinations. Cobalt ranged in percentages in alloys during the war from 66% in Vitallium down to 13% in low carbon N-153—in those alloys where used. In 12 of the 35 chief high temperature alloys it did not appear. No cobalt appeared in the first eight prominent alloys used early in the war.

Chromium ranged from 28% in five of the Haynes Stellite alloys down to 13% in 17-W and Discalloy. It is common to all 35 alloys except Hastelloy B. Nickel ranged from 75% in Inconel X down to 4½% in CSA and was in all alloys save three. Molybdenum was in all 35 except eight, ranging from 15 to 25% in Climax NDRC alloy down to 0.40 for 19-9 W-MO. Tungsten swung from 15.00-25.00% in Vanadium NDRC alloy down to 1.25% in the two 19-9 alloys and was absent from 14 alloy combinations. Columbium's gamut was 4.00 down to 0.40 and appeared in 11 alloys; titanium, 3.00 to 0.30, in six alloys.

Averaging the key elements in 32 hi temp alloys, one gets compositions of: Chromium, 20.4; nickel, 22.4; cobalt, 11.6; molybdenum, 2.11 and tungsten, 1.99, which is a fictitious alloy and does not resemble any of the high temperature alloys listed. Averaging 27 alloys that entered most critical parts—buckets, disks, and stationary parts—we get: chromium, 20.6; nickel, 22.7; cobalt, 14.6; molybdenum, 2.48 and tungsten, 2.50, which most closely resembles the two Haynes alloys, N-155 and N-153.

There are two important and somewhat diverse concepts on functions of the high temperature metals. Where combat equipment is involved high cost and short life are allowable. Thus turbosuperchargers and jet engines need not last too long. For one thing the airplane itself either wears out over a brief span or becomes obsolete. Here the first requisite is for the turbine blades and disks to have good stress-to-rupture qualities.

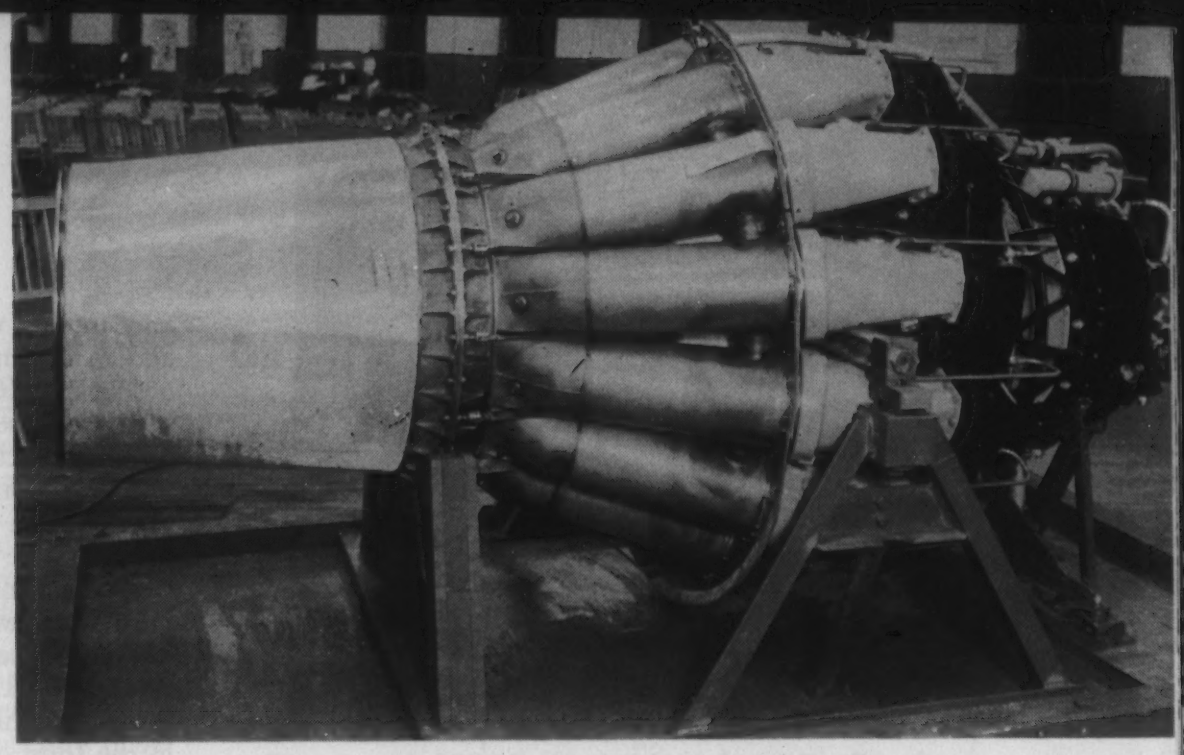
The gas turbine used as a power plant on the surface of the earth is designed to last—say 10 years. Here provision is made for joints and other devices to allow for expansion, which would not be practical in aircraft. Here the ability of the metals to withstand creep (distortion over a long period of time) is a prime requisite. Since such power is highly competitive, being out of the combat zone, it is in this direction that the keenest efforts lie to develop low cost alloys.

The present marine gas turbine made by the Elliott Co. for the Navy has an overall efficiency of 29% against 26% for steam and 33% for diesels. Running at 600 F a gas turbine produces just enough power to run its own air compressors; at 1200 F it becomes an effective heat engine, competing with other prime movers. Metals in the Elliott turbine glow dull red when operating. They will stand up under an estimated life of 100,000 hr.

Needless to say, efficiency of the alloys is the bottleneck which governs progress in gas turbine development. Much concentrated study has been given to high temperature alloys in the past two or three years. As one metallurgist expressed it, perhaps several of the older alloys would be found equal to the more modern alloys if some of the modern techniques for testing them were applied. Stress-to-rupture, creep, damping and fatigue tests at elevated temperatures are the chief tests applied.

What the Metals Must Accomplish

As proved by test and field failure, the highest quality of metals is demanded from the blades or buckets, which are the moving parts of the turbine, with nearly equal quality demanded of the stationary parts, called the vanes, or diaphragm, or nozzles. Almost as severe punishment must be undergone by the wheels or disks. One in good position to observe states that more blade failures than wheels have been reported which is natural since blades have higher rotation speeds and suffer more from hot impinging gases. Strange to relate, however, a prominent maker of power plant and marine gas turbines says that all of his failures have been in stationary, rather than rotating parts. Timken claims for their 16-25-6 alloy: Not a single wheel failed in service. It is a theory that the rim of the turbine undergoes a compression stress whereas the center is in tension. Again an authority has stated that he never heard of a disk failing at the rim, but many failures have occurred at the center. The center can't relax hence residual stress may remain there. The higher the temperature, the less thermal stress develops. Possibly it would be best to reduce this by heating the center of the disk—instead of cooling it as is the usual practice some designs are meant to do.



The G. E. axial flow jet engine which powers the TG-180 is superseding the famous I-40 jet engine.

A typical requirement of a super alloy for aircraft service is that it be able to stand 15,000 or more psi. at 1500 F for 1,000 hr. without failure. The Elliott Co. is building a new gas turbine for marine or power plant use to operate at 1400 F where no stress will exceed 8,000 psi.

What might be termed the super-super alloys are those used in the turbine itself as blades or disks. In this article any mention of high temperature alloy will imply such uses unless stated otherwise. Combustion chambers are usually a stainless steel shell, usually columbium- or titanium-bearing, with a lining of Inconel or Inconel-X which must stand 1900 to 2000 F maximum. The compressors, which operate around 350 F are often of aluminum alloy, typical being 25 ST, or of 316 or 410 stainless steel. Welding electrode material is usually a stainless steel, types 410, 347, 310, or 316. Shaft material is SAE 4140. Other metals are used in the jet engine and gas turbine for earth surface use, but these usually are out of the high temperature zone.

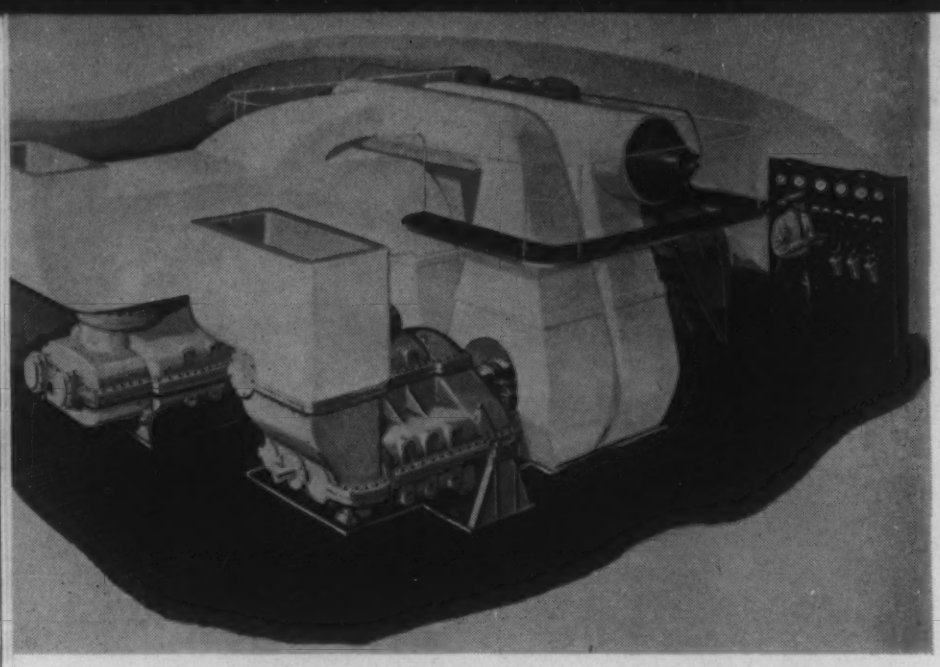
Forged Versus Cast Buckets

One of the main controversies in the field revolves around forged versus cast (precision) blades. One school of engineers maintains that for temperatures above 1300 or 1350 F cast blades are definitely superior, whereas under that the two are on a par. The cast school of thought argues that whatever metal was originally hot-worked, will not stand up perfectly under high heat. The forged school maintains that properties of a casting are not uniform and homogeneous and that the grain is coarser. The casters reply that over a long service creep characteristics of castings are better than in the case of forged buckets. Often the two were used side by side. Thus cast Vitallium alloy was used widely as buckets for the turbine wheel of the turbosupercharger in our combat aircraft. The cast buckets were welded to a forged wheel of 16 chromium-25 nickel-6 molybdenum, with performance of both of a high order. There are instances where wrought buckets performed admirably. It was often a question of which process would lend itself to the fastest production. Haynes Stellite was turning out precision cast buckets for Ford and Allis-Chalmers engines at the rate of 2,000,000 monthly during April, 1944, and total war output was at least 25,000,000.

Metallurgical studies at the General Electric plant at West Lynn, Mass. on as-cast and on forged and heat-treated Hastelloy alloys, A, B and C at 1500 F demonstrated that on stress-to-rupture tests fine-grained forgings were superior to coarse-grained castings only for the first 20 to 50 hr. of test and that for longer periods the castings were superior because their strength, as shown by laboratory rupture tests, did not drop off as rapidly as that of tne forgings. Thus at 200 to 300 hr., the desired length of the accelerated life test on the turbosupercharger unit, the difference in strength of cast and forged alloys was very marked—in favor of cast.

According to one engineer the technical reason for the lower rate of deterioration of coarse-grained castings over fine-grained forgings at 1500 F is believed to be that this temperature is above the equi-cohesive temperature at which grain boundary material and material within the grains have equal strength. Above this equi-cohesive temperature the grain boundaries become weaker and hence coarse grain with less actual grain boundaries is desirable while below this temperature the grain boundary material is stronger than the grain material and hence fine grain with maximum amount of grain boundaries is desirable. With this theory in mind, a patent has been issued involving improvement of the elevated temperature creep strength of wrought nickel-containing alloys by annealing at high temperatures close to the melting point where grain growth occurs. Such an anneal is now generally used on some wrought blade alloys to approach desirable cast properties.

Whereas temperatures undergone by turbosupercharger buckets may be as high as 1500 F, those suffered by jet propulsion equipment are frequently lower, say around 1200 to 1350 F. This is below the equi-cohesive temperature and reverses the advantage of relatively coarse-grained castings over fine-grained forgings. Also, the high-temperature fatigue strength of the cast alloys with coarse grain is not as high as that of the fine-grained forgings or castings. To offset disadvantages inherent in coarse grain, design was improved to make for less vibration and smoother surfaces to prevent incipient strains and cracks.



One of the anticipated applications of gas turbines is in the field of marine propulsion. In this sketch is shown a proposed shipboard installation of an Elliott gas turbine.

Evolution of the Alloys

Now for some history and description of the evolution of steels and alloys used in turbo blades and later jet engines. In 1918 the aircraft turbos were made of SAE 6150 steel and by 1922 of Silchrome No. 1 (0.45 carbon, 8.50 chromium, 3 silicon). By 1928 an English alloy was adopted, K & E 965 (0.38 carbon, 13 chromium, 13 nickel, 3 tungsten and 1.40 silicon). However, the Army Air Forces wished us to be self-sufficient and Universal Cyclops was in 1933 prevailed on to make a 17-W (0.50 carbon, 12 chromium, 19 nickel, 2.2 tungsten, 1.00 molybdenum). From the start of World War II until 1942 the turbos were made from that alloy. Buckets were drop-forged and annealed at 1400 F after forging. There were 144 blades in each supercharger. Meanwhile Allegheny-Ludlum made a K & E 965, equivalent to the British alloys, TPA and Wilcox-Rich 142.

Then General Electric Co. along with Austenal Laboratories adopted the "lost wax" process for the buckets, with Haynes Stellite entering the picture shortly after. This avoided all machining except for shaving on the heads and grinding of tips. In performance they were definitely superior, with higher rupture strength. The alloy was the well-known Vitallium and units were being made of this material at General Electric's Everett, Mass. and Fort Wayne, Ind. plants; at Allis-Chalmers and Ford Motor Co. All raw materials were produced by Haynes Stellite. Allis-Chalmers installed their own precision castings equipment, while Ford bought from Haynes. Austenal built a new plant in Chicago to augment their initial facilities.

The history of the turbo wheels or disks runs as follows. SAE 2335 was first used, but by 1925 material shifted to SAE 6150. Next Silchrome No. 1 was used around 1930. Seven years later 17-W was adopted and in 1941 gamma columbium (see table) was introduced though approved usage was very small and there was no production in quantity. These wheels were difficult to make. The Silchrome had poor ductility while 17-W had good rupture characteristics and some ductility, yet a lot of precipitation occurred near the center of the wheels, reducing ductility. The gamma columbium had good rupture characteristics. However, difficulties were encountered when welding the buckets to the wheel and in drilling and reaming dovetails.

Timken 16-25-6 was adopted for the wheel in 1941 and used during most of the war and proved quite satisfactory. It was adapted for a 6-min. welding operation, buckets to wheel, which gave mass production a decided boost. Tolerances on the buckets could be broader on cast buckets used in the welded assembly.

Another wheel material devised late in the war was EME (see table), a material developed by Midvale Steel Co. for large disk forgings for gas turbines. A general difficulty is production of suitable alloys in the form of rather large forgings made from fair-sized ingots. The development of alloys with suitable properties is only the beginning of the problem. Earlier in the war prominent disk metals were K-42-B and then Discalloy, both Westinghouse materials and confined to developmental units and never used in production.

Jet Propulsion Problems

Jet propulsion engines for aircraft were started in September 1941. The turbines operate at cooler temperatures than turbosuperchargers and turbines rotate at slower speeds, but stresses are similar. The larger size diameter is the biggest problem. This increases tip speed and stresses and decreases the uniformity in quality of the alloys. Buckets for the I-40 jet engine were about 40 times the weight of those of the turbo and had much larger grain size. The jet wheel is approximately 10 times the weight, with buckets 40 times as heavy. The compressor is about 45 times as heavy.

Timken metal was again used for the wheel. Among the troubles at first were cracks in the plane of rotation due to hammering—not where the stress is highest. It was a problem to find the optimum size of ingot or billet to be upset into the finished forging. To determine this G. E. used 150 wheels of 400-lb. each and burst in an overspeed pit to determine variations in processing and alloying and quality of one manufacturer against another. (The cost of forging alone was $450 per wheel.)

Late in the war Bethlehem Steel devised a method for forging from the cast ingot shape direct in the press, securing amazing uniformity of quality. The lack of uniformity of certain vendors previously had been so marked that wheels would burst anywhere from 14,000 to 25,000 r.p.m. The Bethlehem wheels ruptured from 24,500 to 26,000 r.p.m. But these wheels came too late to see war service. The blanks underwent rigid inspection with Zyglo, 2,000,000-volt X-ray and supersonic devices. Nine sets of dies were used to give the wheel its final form. After each pressing, the wheel was placed back in the furnace for heat treatment.

The wheels were flash-welded to an SAE 4140 shaft, using special control of temperature to prevent distortion and promote homogeneous structure. It was not subsequently heat treated except for strain relieving at 1050 F. Later a composite wheel was developed for some designs to get away from large

size of individual pieces. The shaft and center of the wheel of SAE 4340 were welded to a rim of Timken alloy, a welding rod of 29-9 (chromium-nickel) being used. Then the buckets were welded to the Timken rim. This welding material was later superseded by 19-9 tungsten-molybdenum (see table). This welding of buckets differed from the original method of dovetailing in that it provided some dampening effect to lessen vibration of the buckets in the moving turbine.

In making buckets for the I-40 engine there was a limitation to existing forging capacity. At that time fatigue strength was difficult to measure under high temperature conditions until Westinghouse developed the most efficient tester known. With the big grain size of cast buckets fatigue is an important factor. Now in the extreme heat of turbosuperchargers there is recrystallization that relieves strain. Would the same take place with the large grains of jet buckets under the lower temperatures encountered?

For the I-40 jet engine blades or buckets General Electric started out with Vitallium, while in the I-16 engine it used Hastelloy B at first. But since Hastelloy B contains no chromium its resistance to oxidation is poor. G. E. spheroidized it at 1900 F for 24 hr., thereby getting everything to precipitate that would ever do so in service. Vitallium had been used for such buckets but the experience of G. E. showed Hastelloy B the better. In both the I-40 and the I-16 jet engines the buckets were attached to wheels by dovetailing. In two recent jet engines the buckets are attached by welding. One of the more recent and most successful bucket materials is S-816 of Allegheny Ludlum, which showed very good rupture strength where used in one design. (In one instance, however, unwanted grain growth was encountered.)

In jet engines liners of the combustion chamber are important. In one design much trouble was encountered, but later ones proved satisfactory. The chief trouble was that local hot spots developed, making for distortion and cracking. With use of tetraethyl products corrosion set in. G. E. tested 30 possible materials and found two materials best: Inconel and an alloy, 25 chromium, 20 nickel, with 2 silicon. G. E. was using the former when the war ended. Even better was Vitallium which Haynes Stellite could roll by the end of the war. It has five times the life of Inconel linings. However it had not been available in quantity prior to that time.

Sheet metal parts of the jets were usually Type 347 stainless steel, containing columbium, with titanium sometimes substituted. The diaphragm, or stationary part of the turbine, was fabrication welded of the same material, except for one unit made of 25-20 alloy.

An important contribution to the production of turbosuperchargers and jet propulsion equipment was the development of the Unionmelt type of automatic welding, with the help of Linde Air Products at Allis-Chalmers and G. E.'s Fort Wayne plants. This reduced the time needed for welding buckets to wheels from 45 min., required for hand work, to under 6 min. by Unionmelt.

Late War Developments

Near the close of the war two high temperature alloys were developed that show unusual promise and have received praise in several quarters. One was developed by the Climax Molybdenum Co. and is tentatively called Climax Moly NDRC Research (see table). It contains the highest chromium content of all, 60% or more, has highest rupture strength and other desirable qualities, though is inclined toward brittleness. It has not been used practically, for there is more exploratory work to be done. It is made in a vacuum furnace.

The second metal is that of Vanadium Corp. and is tentatively designated as Vanadium Corp. NDRC Research (see table), the feature being the almost equal percentages of four common alloying elements: Chromium, nickel, cobalt and tungsten, to which is added a trace of boron.

According to Haynes Stellite engineers—and their opinions must be honored in view of the company's prominent role—there are three leading materials for jet turbine buckets: Hastelloy B, Vitallium and S-816. They say that Vitallium is most used to date. In the same breath they predict that important heat alloys of the future will be H. S. Nos. 27 and 30 (see table).

Metallurgical Considerations

Here are some of the important metallurgical considerations in choosing high temperature alloys. Chromium of course provides corrosion and oxidation resistance. Molybdenum is usually considered the most effective element for high temperature strength. To balance the chromium and molybdenum and assure a purely austenitic steel, free from delta iron, nickel, say at least 25%, is needed. Delta iron would lower high temperature strength and cause low ductility on aging at operating temperatures through formation of sigma phase. Low carbon is needed for good forging and welding. Tungsten, vanadium, titanium and columbium are inclined to introduce melting difficulties. Nitrogen stabilizes austenite and nitrides have greater resistance towards spheroidization at elevated temperatures and aid creep strength. Increased manganese improves forgeability and silicon is an aid to scale resistance.

Chromium is of course an extremely important element. An analysis of 28% is the most corrosion and heat-resistant one available, but develops undesirable mechanical properties because of changes in constitution during heating. A brittleness develops at 900 F which is relieved by heating to 1500 F and cooling rapidly. During service at 1200 to 1700 F nothing unusual occurs if cooling below 1200 is rapid. At 1700 F and higher large grain growth results in brittleness. However the analysis is widely used and bad mechanical properties are taken care of by careful use. Only 16% chromium is needed to resist oxidation from 1300 to 1500 F; between 1500 and 2150 a 27% chromium is needed.

The higher the chromium content, the greater concentration of chromium oxide and the less scaling. Oxides of silicon and aluminum react with water

High Temperature Alloys

Alloy Designation	C	Mn	Si	Cr	Ni	Co	Mo	W	Cb	Ti	N	Fe	Others	Maker	Parts Used In
19-9 W-Mo	0.10	0.60	0.50	19.00	9.00	—	0.40	1.25	0.40	0.35	—	Bal.		Universal Cyclops	Welding rods, buckets, wheels and casings (cast)
19-9 DL	0.30	1.00	0.55	19.00	9.00	—	1.25	1.25	0.40	0.30	—	Bal.		Universal Cyclops Steel Corp.	Gas turbine wheels, blades, hi temp. bolts, ducts, rockets
16-25-6	0.08	1.50	0.80	16.50	25.00	—	6.25	—	—	—	0.10	Bal.		Timken Roller Bearing	Wheels
17-W	0.30	0.60	1.00	13.00	20.00	—	0.60	2.25	—	—	—	Bal.		Universal Cyclops Crucible Steel Co. Midvale Steel Co.	Turbosupercharger, buckets and wheels
Gamma Cb	0.40	1.00	1.00	15.00	25.00	—	2.00-4.00	—	4.00	—	—	Bal.		Allegheny Ludlum Universal Cyclops	Turbosupercharger, wheels
ATV-3	0.35	1.25	1.00	15.00	27.00	—	—	4.00	—	—	—	Bal.		Midvale	Buckets and wheels (integral)
CSA	0.35	4.00	0.50	18.50	4.50	—	1.35	1.35	0.60	—	—	Bal.		Crucible	Wheels
EME	0.10	0.75	0.50	19.00	12.00	—	—	3.25	1.25	—	0.15	Bal.		Midvale Steel Co.	Large disk forgings for gas turbines (In development stage)
Low Carbon N-155 Multimet	0.15	1.00	0.50	20.00	20.00	20.00	3.00	2.00	1.00	—	0.14	Bal.		Haynes Stellite	Wheels, bolting, gas turbine blades, tail cones and ship propulsion turbines
Low Carbon N-153	0.15	1.50	0.50	16.00	15.00	13.00	3.00	2.00	1.00	—	0.14	Bal.		Haynes Stellite	(Experimental)
S-495	0.45	1.00	0.50	14.00	20.00	—	4.00	4.00	4.00	—	—	Bal.		Allegheny Ludlum	
S-590	0.45-0.40	1.50-0.75	0.50-0.65	20.00	20.00	20.00	4.00	4.00	4.00	—	—	Bal.		Allegheny Ludlum	Wheels and buckets
S-816	0.40	0.50-0.75	0.50-0.65	20.00	20.00	44.00	4.00	4.00	4.00	—	—	4.00		Allegheny Ludlum	Buckets
Discalloy	0.04	0.50	0.50	13.00	24.50	—	3.00	—	—	2.25	—	—	Al 0.60	Westinghouse	Wheels
K-42-B	0.05	0.70	0.40	18.00	42.00	22.00	—	—	—	2.00	—	13.00	Al 0.60	Westinghouse	Turbosupercharger, blades
Refractalloy	0.03	0.70	0.65	18.00	37.00	20.00	3.00	—	—	3.00	—	Bal.	Al 0.30	Westinghouse	
Inconel X	0.04	0.75	0.50	14.00	75.00	—	—	—	1.00	3.00	—	6.00	Al 0.60	International Nickel	Buckets, wheels and liners of comb. chamber
Inconel	0.15	1.00	0.50	12.-15.00	75.00	—	—	—	—	—	—	9.00	Cu 0.50 Max.	International Nickel	Used as liners of combustion chambers
Hastelloy B	0.05	0.60	0.25	—	65.00	29.00	—	—	—	—	—	4.50		Haynes Stellite	Buckets
Vitallium	0.30	0.30	0.25	27.00	2.00	64.00	5.00	—	—	—	—	2.00		Austenal Laboratories	Buckets, turbosupercharger and jet buckets, nozzle vanes, liners, tail cones, heat exchangers
6039	0.40	0.30	0.25	26.00	33.00	33.00	5.00	—	—	—	—	1.00		Haynes Stellite	
Vanadium Corp. NDRC Research	—	—	—	25.00-35.00	20.00-30.00	20.00-30.00	—	15.00-25.00	—	—	—	—	B 0.25-1.00	Vanadium Corp.	
Climax Moly NDRC Research	—	—	—	60.00	—	—	15.00-25.00	—	—	—	—	15.00-25.00		Climax Molybdenum	
HS-23 61 NR-60	0.40-0.50	—	—	28.00	—	Bal.	—	6.00	—	—	—	—		General Electric	Blades for gas, jet engine, locomotive turbines
HS-30 422, 19 NR-12	0.40-0.50	0.30	0.25	26.00-28.00	15.00-16.50	49.50-51.00	6.00	—	—	—	—	1.00		Haynes Stellite	Blades for gas, jet engine, locomotive turbine and hollow blades
X-40	0.40-0.50	—	—	25.00-28.00	10.00-12.00	54.00-55.00	—	7.00-7.5	—	—	—	0.60		General Electric	Gas turbine and jet engine blades
Hastelloy C	0.15	1.00	1.00	15.00-17.00	55.00	—	17.00	5.00	—	—	—	5.00-6.00	Al 1.0	Haynes Stellite	
Type 410 Stainless	0.15	1.00	—	11.5-13.5	—	—	—	—	—	—	—	Bal.			Blading for axial flow compressors. Moving or stationary blades
Type 347 Stainless KA2S Cb	0.10	1.50	0.75	18.00	10.00	—	—	—	0.80	—	—	Bal.			Outer combustion chambers. Castings of turbine housing, exhaust cone assembly
KA2S Mo	0.08	—	0.70	18.00	13.00	—	2.50	—	—	—	—	Bal.			Diaphragms
Type 310 Stainless	0.25	2.00	1.50	24.00-26.00	19.-22.00	—	—	—	—	—	—	Bal.			Sheet metal parts
25-ST	—	0.4-1.2	0.5-1.2	—	—	—	—	—	—	—	—	—	Cu 3.9-5.0 Bal. Al		Compressors

to form hydroxides (which are mild corrosives) whereas chromium oxide remains inert and protects the metal surface. As the carbon content of chromium steel increases to 1%, resistance to scaling decreases. Carbon ties up chromium as carbides, hence chromium can no longer diffuse into the surface. Carburization causes loss of ductility and toughness and destroys corrosion-resistance.

Most austenitic stainless steels carburize at over 1300 F. The addition of silicon to stainless steel with 25% chromium and 20% nickel brings about a marked reduction in tendency to become carburized. With silicon over 1.70 the 25-20 stainless steel shows no carburization. The 28% chromium steel that is ferritic at all temperatures resists carburization better than stainless. The non-hardening 12% chromium steel, with aluminum and low carbon, remaining ferritic up to 1700 F, also resists carburization. It can be carburized at 1900 to 2000 F, however.

For service at 750 to 1000 F regular stainless steel is used in the annealed state. The straight chromium-nickel austenitic stainless steels show more strength than plain chromium steels at over 1000 F. The moly-bearing 18-8 (Type 316—see table) is the strongest of the regular grades of stainless at high temperatures.

The Germans resorted to three main classes of super alloys for high temperature applications, characterized by: (1) "Tinidure" which analyzed: carbon, 0.10; chromium, 15.00; nickel, 30.00; titanium 1.80%. (2) "Chromadure," analyzing: carbon, 0.10; manganese, 17.50; silicon, 0.60; chromium, 12.50; with vanadium content of 0.12%. (3) F.B.D. or "Bohler," containing: carbon, 0.15; manganese, 1.00; silicon, 1.25; chromium, 17.50; nickel, 16.00; molybdenum, 1.75; columbium, 2.00 and vanadium 0.12%. German alloys had poor creep characteristics and there were many bucket failures.

Other Alloy Parts

Composition of certain parts of turbosuperchargers and jet engines, not subjected to extreme temperatures, but yet vital are fraught with a certain amount of interest. In the turbos there were certain sheet metal parts. After 1932 the standard was Type 316 stainless steel. But to attain a metal with more rigidity the Allegheny Ludlum Co. developed a technique using 25-20 (see table) for making the diaphragm by centrifugal casting. This became standard throughout the war. There was also a trend to use 18-8, with titanium. KA2S Mo was perfectly satisfactory for nozzle boxes. For compressors 25ST aluminum (see table) was consistently good, having the right balance of ductility and strength. Engineers tried 14 ST aluminum but rejected it in favor of 25 ST. The compressor must stand 350 F.

In building jet engines experience gained with superchargers came in handy. The compressors were again made of 25 ST in the form of 900-lb. aluminum forgings which were given Zyglo and etch test inspection after milling out the blades. Those with cracks or segregation were discarded.

Several light metal parts were made of cast magnesium alloys, with no trouble encountered. Air adapters were of 355T-51, with oil deflectors of X-750, having non-scoring properties, the analysis being: Copper 1, tin 6, nickel 1, balance aluminum. The axial flow compressor of the I-40 engine was an 11-stage compressor, the first 10 stages of 24 ST and the last of 410 stainless steel. The 24 ST consists of: Magnesium, 1.5; copper, 4.5; manganese, 0.60; balance aluminum. Compressor assembly casings were of 356-T 6 consisting of: Silicon, 7.00; magnesium, 0.30; balance aluminum. Magnesium alloys were used for compressor casings.

As to the future, progress will be rapid. The metallurgists are developing alloys that may stand temperatures of 1800 to 2000 F, at least with satisfactory creep tendencies. The goal is of course higher operating temperatures since efficiency of the turbine increases with the temperature. With our own eyes we saw one of the alloys mentioned in this article hold up at 60,000 psi. at 1500 F on a tensile testing machine at Battelle Memorial Institute.

Alloys are constantly giving better creep performances. Earlier alloys would creep 0.00001% per hr. at 1500 F at 5000 psi. The Navy wanted this performance at 7000 psi. Some present alloys can attain that at even 10,000 psi.

The Elliott Co. turbine, operated at 1200 F, is being superseded at the same company by one to operate at 1400 F, several different alloys and types of insulation to be used. A feature of such turbines are the provisions for expansion, for many of the alloys have a coefficient of expansion 50% greater than steel. Engineers are learning better where to cool by air streams and where to operate hot. The modern theory is that there has been too much cooling of certain parts in the past. We first believed that Germans used hollow buckets for sake of sending air through them to cool, but we have since learned that it was primarily to save scarce materials.

Perhaps the most striking prediction is that of a prominent metallurgical authority that in 10 to 15 yrs. the average automobile will be powered with a gas turbine engine, the disk to be 3- to 4-in. dia., with blades 1-in. long. In ten years, he continues, wrought and cast metals for high temperature service will be two or three times as strong as those used today.

With the gas turbine we've gone back to the simple water wheel power idea of a few centuries ago, states Prof. Lionel S. Marks, dean of the school of engineering at Harvard. Our reciprocating and cycle engines have been the most complex and fantastic mechanism that either the gods or man could devise. It's good that we are turning simple again.

The author wishes to acknowledge aid in preparing this article to several sources. Especially worthy of being mentioned are the following: C. T. Evans, Jr., Elliott Co., Jeannette, Pa.; W. L. Badger, General Electric Co., West Lynn, Mass.; Howard C. Cross, Battelle Memorial Institute; Russell Franks, Union Carbide and Carbon Co.; F. S. Badger, Jr., Haynes Stellite Co.; A. L. Feild, Rustless Iron and Steel Div. and J. B. Johnson, Wright Field, Dayton, Ohio.

Charging a load of bearings into a pit-type carburizing furnace. (Courtesy: Hyatt Bearing Div., General Motors Corp.)

Changes in composition of 6120 carburizing steel increase hardenability and permit an increase in section in which it can be applied.

Chromium-Vanadium Carburizing Steel "6120"

by F. F. FRANKLIN, *Metallurgical Engineer, Vanadium Corporation of America*

ACCEPTED SPECIFICATIONS for the carburizing grade of chromium-vanadium steel have undergone recent changes. Composition requirements have been altered by lowering of the chromium range and of the minimum vanadium, raising of the manganese range, and narrowing of the range specified for carbon. Specifications corresponding to the 1945 AISI number for this grade of steel, A 6120, are given in Table 1, together with those formerly given for SAE 6120.

The outstanding effect of this change in specification upon the physical properties of chromium-vanadium carburizing steels has been to increase the hardenability which, of course, resulted in an increase in the thickness of section in which this type of steel could be applied.

To determine the properties of steel made to the new specification, A 6120, with respect to those corresponding to the former SAE 6120, a heat of each analysis was made in an induction furnace under carefully controlled conditions. To permit the most satisfactory comparison of alloy content of the two compositions, both heats were of the same carbon content, and all conditions of manufacture were kept as closely identical as possible.

In rolling or forging of these small ingots the steel is by no means worked as much as in an ingot of commercial size, and consequently does not develop as high physical properties as the commercially manufactured steels of the same composition. For purposes of comparison, however, laboratory heats can be used, especially if melting conditions are carefully controlled so that the melting practice can be eliminated as a variable factor.

Analyses of the two heats are given in Table 2.

Core Properties

Hardenability was determined by means of standard cupped or "L" specimens, quenched in the fixture from 1700 F.

Hardenability curves of both SAE 6120 and the newer A 6120 are shown upon the accompanying chart, and some of the values are given in Table 3.

The greater hardenability of A 6120 is at once apparent, and is reflected to some extent in improved

TABLE 1. Specifications

	Carbon	Manganese	Phosphorus	Sulphur	Silicon	Chromium	Vanadium
1945 A 6120	0.17/0.22	0.70/0.90	0.040	0.040	0.20/0.35	0.70/0.90	0.10 min.
Former SAE 6120	0.15/0.25	0.30/0.60	0.040	0.050	0.15/0.30	0.80/1.10	0.15 min.

TABLE 2. Analyses of Induction Heats

Heat Type	Carbon	Manganese	Silicon	Chromium	Vanadium
No. 1 SAE 6120	0.19	0.54	0.17	0.99	0.17
No. 2 A 6120	0.10	0.85	0.24	0.88	0.11

tensile properties described in the following section. It will be noted that this improvement in hardenability will permit the through hardening of gears, shafts, and other parts of heavier cross-section than those to which the older SAE 6120 was applicable.

Because of the interest in application of this steel to direct-quenched parts, specimens from both heats were pseudo-carburized at 1675 F, and quenched from the carburizing box. Details of the treatment, together with the properties developed, are shown in Table 4.

Although there are differences in the physical values obtained from the two heats, these differences become insignificant when the conditions of their manufacture are considered. The high impact value and toughness of the older SAE 6120 has been retained by A 6120 without loss of tensile strength or yield point.

The direct-quenching operation is sometimes varied by furnace-cooling carburized parts from the carburizing temperature to the normal hardening temperature before quenching. Table 5 shows the properties of bars which were pseudo-carburized at 1675 F and then furnace-cooled to 1575 F before quenching.

Here again A 6120 exhibits slightly greater strength than the older analysis. In this case, furthermore, A 6120 possesses greater toughness, as denoted by Izod impact values.

It will be noted that A 6120 when furnace-cooled 100 F below the carburizing temperature before quenching retains both strength and impact resistance of the specimen quenched without such pre-cooling.

Reproduction of similar physical properties in spite of the wide difference in quenching temperatures, as illustrated in Tables 4 and 5, is in keeping with experience accumulated during years of use of chromium-vanadium steels. This lack of sensitivity to changes in quenching temperatures is due to the maintenance of fine grain structure at temperatures appreciably higher than the upper critical point.

Resistance to grain coarsening can be effected by treatment of steel during its manufacture, and this is usually carried out by the addition of aluminum to the molten metal. Vanadium steels, on the other hand, are inherently fine grained, and while they, too, are usually treated with aluminum (in limited amount), this inherent characteristic provides an added safeguard against coarsening at heat treatment and carburizing temperatures, and extends the range of such temperature within which these steels can be heated without grain coarsening.

Case Properties

Properties of the carburized cases of chromium-vanadium and other types of steel have been studied carefully by O. W. McMullan (*Transactions ASM*, Vol. 23, 1935, page 319) and others. McMullan commented on the presence of spheroidal carbides in the high carbon cases of chromium-vanadium steels, which are known to give added wear-resistance to surfaces in which they occur. He also found the rapid rate of carbon penetration in chromium-vanadium steels not to be exceeded by any other type examined.

TABLE 3. Hardenability Tests

Standard Cupped Specimens
(Quenched in Fixture from 1700 F)

Heat	Type	To Rc 40	To Rc 50
No. 1	SAE 6120	0.30 in.	0.75 in.
No. 2	A 6120	0.97 in.	1.21 in.

TABLE 4. Direct-Quenched from Carburizing Temperature

1-in. dia. bars
Normalize—½ hr. 1725 F
Pseudo-Carburize—16 hr. 1675 F
Direct-quench in oil
Temper—350 F

Heat	No. 1	No. 2
Grade	SAE 6120	A 6120
Yield Point	97,000	102,750
Tensile Strength	126,050	131,750
Elongation	15.0%	15.5%
Reduction of Area	48.2%	42.8%
Brinell (3000 Kg.)	271	282
Izod	66.0, 65.0	63.0, 66.0
Vickers on Izod (30 Kg.)	267	258

TABLE 5. Cooling to 1575 F Before Quenching

1-in. dia. bars
Normalize—½ hr. 1725 F
Pseudo-Carburize—16 hr. 1675 F
Furnace-cool to 1575 F
Direct-quench in oil
Temper—350 F

Heat	No. 1	No. 2
Grade	SAE 6120	A 6120
Yield Point	98,650	102,400
Tensile Strength	126,500	133,500
Elongation	16.0%	14.5%
Reduction of Area	48.1%	41.6%
Brinell (3000 Kg.)	268	280
Izod	56.0, 52.0	60.0, 63.0
Vickers on Izod (30 Kg.)	269	256

TABLE 6. Carbon Content of Case

1.5-in. dia. bars
Normalized—¾ hr. 1725 F
Machined accurately to 1.25 in. dia.
Carburized—8 hr. 1700 F
Furnace-cooled

Heat	No. 1	No. 2
Grade	SAE 6120	A 6120
Location		
At surface (0.0005)	1.97%	2.18%
" 0.010 depth	1.22	1.13
" 0.020 "	1.14	1.12
" 0.030 "	1.02	0.98
" 0.040 "	0.89	0.82
" 0.050 "	0.73	0.67
" 0.060 "	0.56	0.49

Quenching a heat, which has been carburized in a pit-type furnace, into oil by means of an elevator quench. (Courtesy: Hyatt Bearings Div., General Motors Corp.)

The low rate of carbon drop between surface and core which characterizes carburized chromium-vanadium parts, as well as the excellent bonding effected between case and core, is well known to manufacturers in the case hardening field.

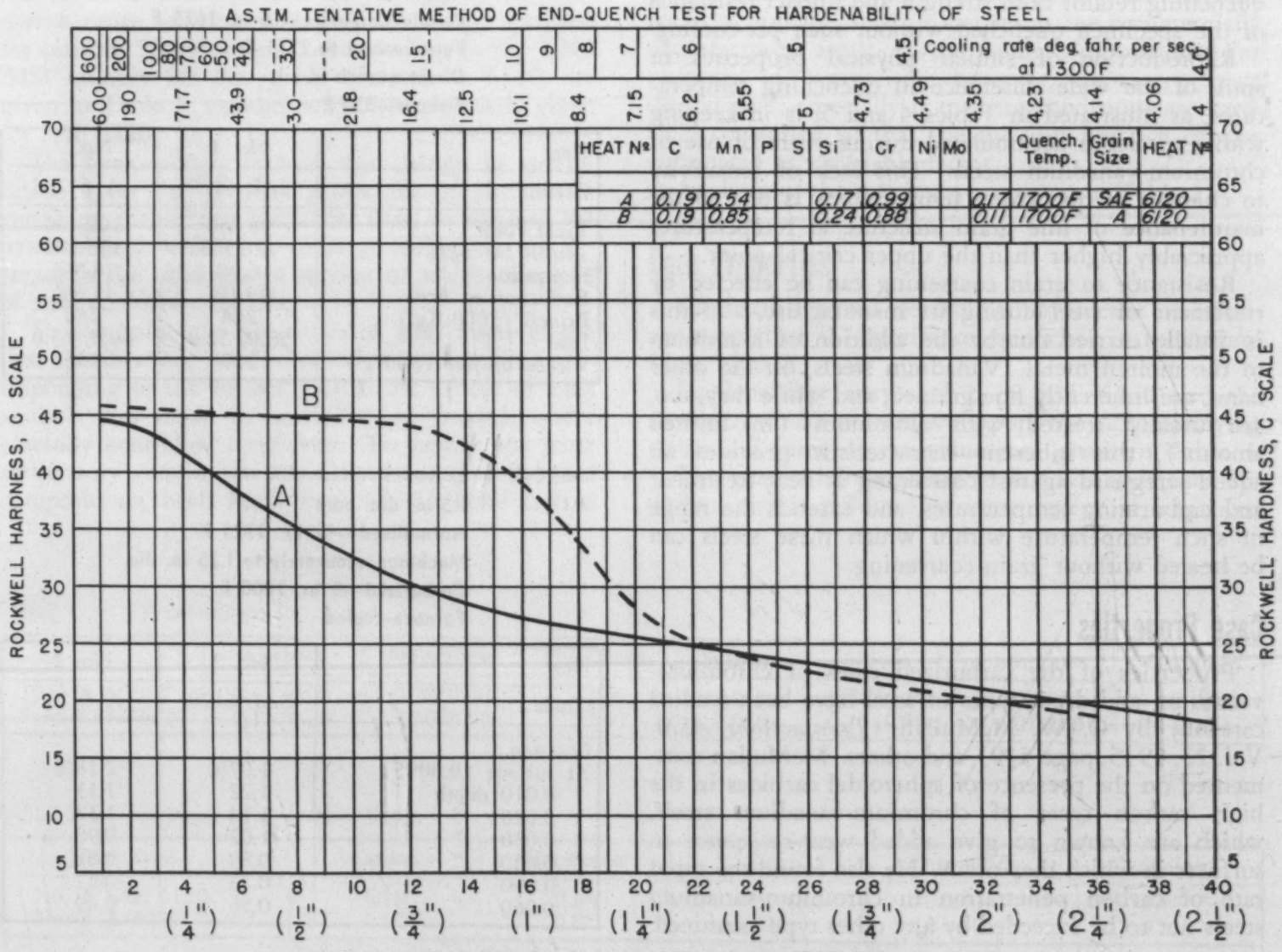
To determine the nature of carbon absorption and diffusion in the investigation of SAE 6120 and A 6120 carried out by the Vanadium Corporation of America, samples of both analyses were carburized in Carbo S for 8 hr. at 1700 F. The rates of carbon absorption and diffusion were found to be approximately the same for both compositions, although diffusion in the SAE 6120 seemed slightly faster. The extreme outer surface (0.001 in.) absorbed about 2% carbon. This partially explains the rapid rates of diffusion in chromium-vanadium steels, since this rate depends, among other things, upon the concentration of carbon in the outermost zones.

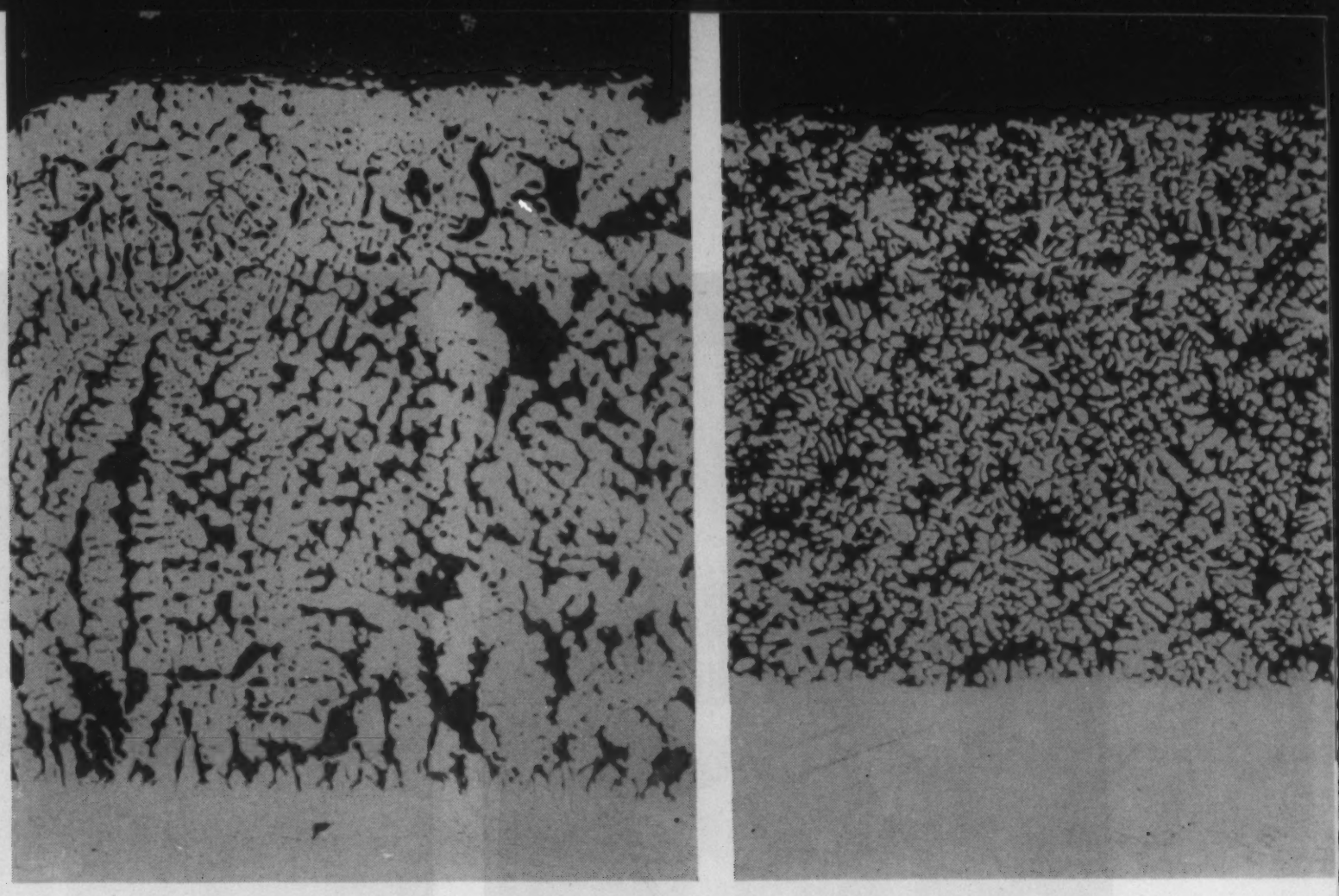
The carbon content of the carbon carburized cases, at intervals of 0.010 in., are given in Table 6 for both steels.

Summary

Steel made to the AISI specification A 6120 compares favorably with the former SAE 6120 in carburizing applications. When direct-quenched, it possesses a little greater strength and maintains the excellent impact resistance and ductility values of the older analyses.

The change in specifications has increased hardenability. This deeper hardening has extended the range of possible applications of chromium-vanadium steels by increasing the thickness of section in which they may be heat treated.





Photomicrographs—Sections through bearing strip of copper-lead and of copper-lead with silver show the effect of silver in reducing segregation.

Continuous Casting of Alloy Bearing Strip

by T. W. LAMB and E. C. JETER, *Chemical Engineering Dept., Ford Motor Co.*

ALLOY BEARINGS of the copper-lead type, having a composition of about 65% copper and 35% lead, have won recognition in the past by their performance under heavy-duty conditions. The alloy is usually cast against a steel back, and quick-cooled through the steel to prevent segregation of the lead. During the war the shortage of tin, and later of cadmium, made this copper-lead alloy a desirable substitute for other bearing metals, and its service under severe conditions, as in aircraft motors and military trucks, indicates that it will keep most of the gains made.

The Ford Motor Co. decided to develop a connecting rod bearing for its cars and trucks, using the copper-lead alloy for the bearing metal, but adapting it to the floating type of bearing. For this purpose it was necessary to coat both sides of the steel backing with the alloy, making chilling in the ordinary manner impossible.

Early experiments showed that when the applied alloy was permitted to cool from the outside, instead of chilling through the steel, lead segregated at the alloy-steel interface. Nickel, tin or silver, added to the alloy in small percentages, reduce segregation, and

Reducing atmosphere, alloy pot, casting pot and cooling jacket are all combined in an ingenious arrangement for steady production of bearing metal.

Coil of steel strip on rack being started to coating furnace.

Pouring bearing alloy into the coating furnace. Cover is shown latched up, with steel strip being fed through.

after numerous experiments it was found that a silver content of from 3 to 20% would greatly retard segregation even under the conditions imposed by the double facing of bearing metal. The most economical composition was found to be one with 5 to 6% silver, with lead at 35 to 40%, and the balance copper. Iron is held to a maximum of 0.5%. Tests demonstrated that this alloy was entirely satisfactory.

Referred to by the Ford Company as the "Silvaloy" bearing, the composition is essentially a copper-lead alloy with silver added to prevent segregation and the consequent creation of a weak area between the bearing alloy and the steel reinforcement.

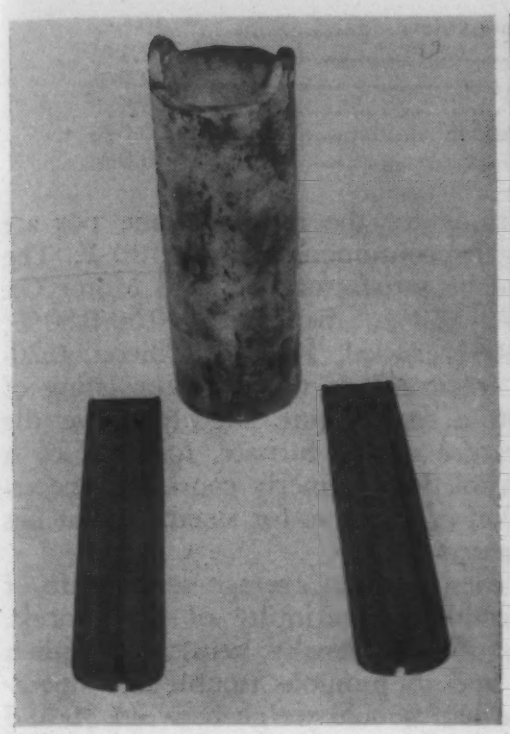
The manufacture of floating bearings involved production of this bearing strip, in quantities commensurate with war production, and afterwards with peacetime schedules for automobiles. The Ford Motor Co. was able to utilize a process developed about 10 years ago, and patented in 1937, in which the alloy is continuously cast against both sides of the steel strip. The bearing strip is then cut off to the proper length and formed into half-round bearings, which are finished by turning down the outside diameter on a high-speed lathe, and broaching the inside diameter.

For the steel reinforcement, a low carbon open hearth hot rolled 0.075-in. strip is used. It is supplied to the process in coils with approximately 800 ft. of strip in each. The strip is about 2 in. wide, allowing for a small amount of trim on either side for production of the finished bearing.

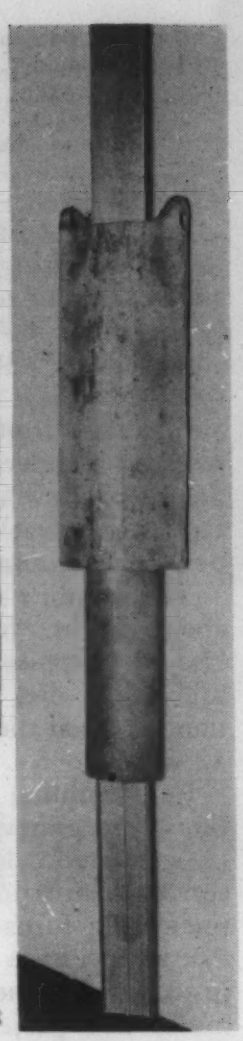
The coils are placed on racks on the main floor, below the gallery on which the alloy is melted. The strip passes over a set of stationary rolls so placed as to permit it to travel upwards to the gallery, then to move in a wide curve to a point directly above the sweat furnace. Here it straightens out and moves downward in a straight line into the furnace unit in which the coating is done.

The sweat furnace is an ingenious combination of controlled atmosphere, molten alloy pot, casting mold, and cooling jacket, in which the entire process of heating the strip, casting the alloy on both sides, and chilling the finished material takes place continuously. The strip moves through at the rate of about 10 in. per min., although this rate can be bettered slightly if necessary. The pulling is done by knurled steel wheels, acting on the coated strip just below the cooling jacket, the entire strip being towed from this point. Since the casting is done continuously, 24 hr. a day, the end of the strip in each coil is welded to the beginning of the next coil, and no interruption occurs. The furnace is gas fired, and is held at 2100 F, at which temperature the alloy is quite fluid.

As the strip passes into the top chamber of the furnace through a slotted cover it is both preheated and subjected to a reducing atmosphere. The high temperature of the bath tends to assist the reducing

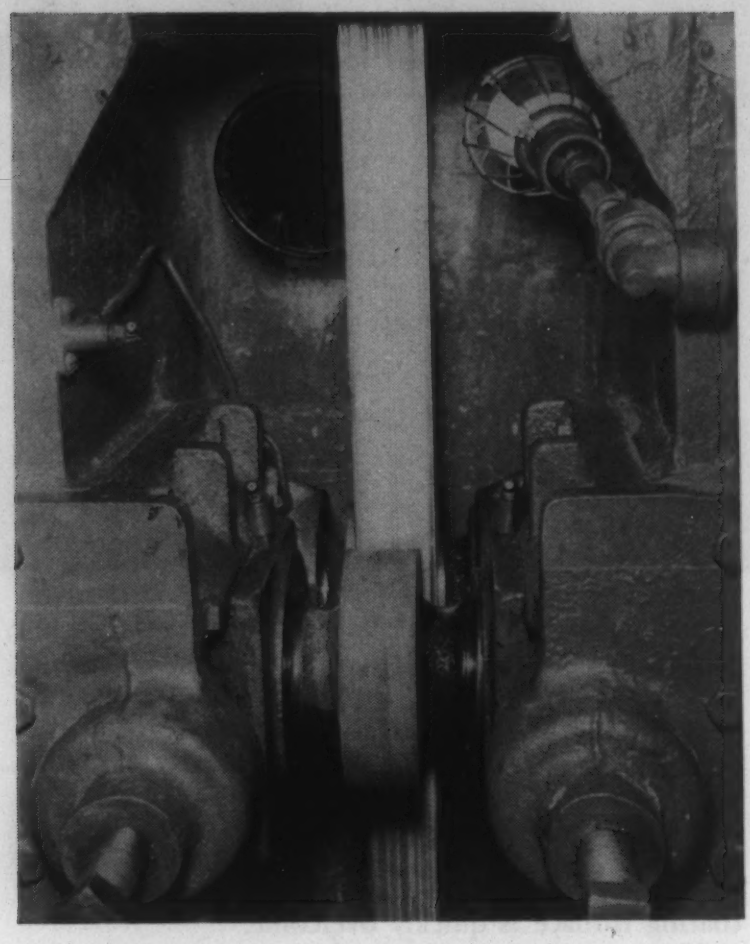


A



B

(A) Nickel-chromium alloy pot and graphite die halves, disassembled. (B) Pot and die assembled, showing how steel strip enters the pot and coated strip leaves from the water-jacketed die.



The knurled wheels provide the motive power for the passage of the strip.

atmosphere in eliminating any slight traces of oxidation on the surface of the steel. No preliminary cleaning is given the strip. To insure cleanliness and good bonding, a top bath of a borox-base flux is maintained over the molten alloy, and the preheated strip passes downward into this as it is slowly drawn through the furnace.

A nickel-chromium alloy pot contains the molten alloy, with its cover of flux. The pot is made in the form of a heavy sleeve, flared at the top, and tapered and sized at the bottom so as to fit snugly around the graphite die or casting mold, which forms the bottom of the pot. About 5 in. of the graphite die is telescoped into the pot, and the bottom of the pot is flush with the bottom of the furnace.

The graphite die, made in matching halves, is about 12-in. long, and is made from 2-in. by 4-in. rectangular electrode stock. It is important that the extruded electrode stock be highly graphitized, and of high density. A slot is machined in each half, and in the half that will cast the surface later to become the inside diameter of the bearing a ridge is formed that will produce an oil groove in the finished bearing. About ¼ in. of the steel strip at each side moves through closely fitting grooves in the die, serving as guides. These edges of the strip are not coated with bearing metal, and are milled off in making the bearing. Two ports in the upper end of each half of the die admit molten alloy from the pot above. The groove in each half bridges over just above these ports, closing off the die cavity from the reservoir of fluid metal. About 0.004-in. clearance over the strip thickness is permitted in the slot through this bridge.

The lower half of the graphite die is encased in a water jacket, through which a sufficient volume of water is circulated to solidify the bearing alloy and to cool it to about 200 F within a few inches of travel. The graphite die is, of course, open at the bottom, and the metal admitted through the ports at the top of the die, at 2100 F, must be solidified before it reaches the end of the die. Quick cooling, from 2100 F to about 200 F in the time required to pass through the die, also helps to prevent segregation of the lead.

Immediately below the water jacket is the set of motor-driven knurled rolls that move the entire length of strip. After passing through these rolls the bearing strip feeds into an automatic cut-off press that cuts it into approximately 11-in. lengths. This length is enough to make three half bearings. After milling off the uncoated edges of the strip the remainder of the process for manufacture of the bearings is performed elsewhere, and consists of cutting to proper lengths for half bearings, pressing into semi-cylindrical form, turning off the outside diameter, and broaching the inside diameter.

The furnace from which the metal is cast serves only as a sweat furnace, and the alloy must be made

up and melted in another unit. This is done in a small induction furnace, located near the bearing strip casting unit. The nickel-chrome pot in the sweat furnace holds 10 to 12 lb. of metal. About 6 lb. of the total amount is used per 20 min., and the batch is then replenished, so that the melting furnace must make up a batch in slightly less than this time. One melting furnace feeds five coating furnaces, melting down batches of about 30 lb. well within the 20-min. requirement.

Batches for the melting furnace might consist of:

Back scrap	15 lb., approx.
Copper	7 lb., 11 oz.
Lead	6 lb.
Silver	12 oz.

The batch melts down in about 12 min., and is brought to the required temperature in well under the 20 min. necessary. A cover of an ordinary glass slag is maintained over the molten metal. Refilling of the pot in the sweat furnace is accomplished by withdrawing a ladle of metal from the melting furnace, raising the cover of the sweat furnace, and pouring in the alloy. Passage of the steel strip is not stopped during the process. The metal in the melting furnace is brought to 2300-2350 F for transferring, so that any chilling effect resulting from opening the coating furnace is quickly overcome.

The atmosphere maintained in the coating furnace is obtained by cracking propane, and is highly reducing. A typical analysis would be:

Carbon monoxide	20.6%
Methane	2.1%
Hydrogen	32.0%
Nitrogen	45.3%
Carbon dioxide	0.0%
Oxygen	0.0%

Strip cut to lengths for fabricating into bearings.

Service conditions for the nickel-chrome pot are severe, requiring its continuous use at 2100 F. The analysis found to be satisfactory by Ford Motor Co. is: Carbon, 0.70-0.80%; manganese, 0.60-0.80%; chromium, 25-30%; nickel, 18-20%; silicon, 0.20-0.60%. A heat treatment of the pots, consisting of air cooling from a temperature slightly above the working temperature of the furnace, followed by a draw and slow cool, was formerly considered necessary in preparation of the pots for assembly, but has now been eliminated.

The graphite dies, with an average service life of about 35 hr., limit the continuity of the process. Use of graphite of high density helps to lengthen life of the dies and to promote trouble-free operation. A good die half should weigh between 30 and 32 oz.

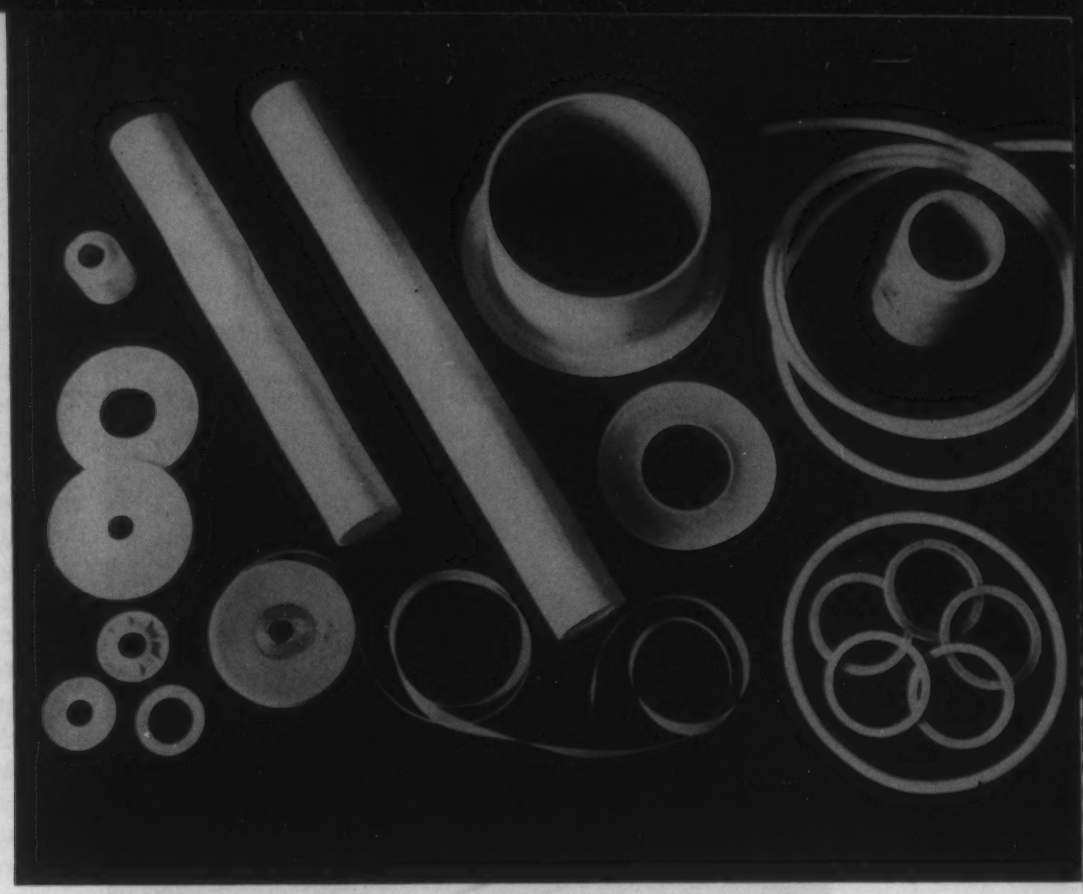
In assembling the coating unit and starting operations, the graphite die is first placed in the water jacket. Guide slots in the bottom of the die assure correct positioning. The alloy pot is then placed in a preheating furnace, brought to 1900 F, and held at that temperature for 1 hr. The coating furnace is adjusted so that the die is in the center of the furnace muffle and projecting about 5 in. into the furnace proper. With the furnace at 2100 F, and the graphite die still cold, the heated pot is passed down from the top, through the muffle, and dropped gently over the die. As it heats, the graphite die expands tightly into the tapered bottom of the pot, and its two halves are squeezed firmly together. The assembly is then complete for the life of the die.

The steel strip is next threaded through the furnace pot, the die, and into the knurled rolls. Molten alloy is then added to the pot, and operations are begun.

As the coil of strip steel is exhausted from the rack, a second coil is started by butt welding the new coil to the end of the first. The weld is made manually with an electric arc, and carefully ground down flush, since clearance in the die is close.

The Silvaloy bearing was developed as a substitute for cadmium bearings due to the shortage of cadmium during the war. However, when this new bearing was tested, particularly on heavy duty trucks and military vehicles, it was found to be superior to the bearings formerly used. Bearings in heavy duty engines running in heavily loaded haulaway trucks have given more than 50,000 miles of service and have been returned in excellent condition. The life of the new bearings has been from two to three times that of the cadmium bearings they replaced.

Exhaustive tests on the dynamometer stands have shown many runs of more than 40,000 miles with the alloy bearing. Wear has been reported quite low. In the case of the bearings that had given 50,000 miles of service in trucks, the wear on the wall thickness of the bearings was from approximately 0.00015 to 0.0015 in., while wear on the diameter of the crankpin was from 0.001 to 0.002 in.



This new tetrafluoroethylene resin of DuPont's is displayed in the forms of flared tubing, rod, pipe, gaskets, beading, coaxial cable spacers, valve stem packing and tape.

A Heat and Chemical Resistant Plastic

—A NEW MATERIAL PREVIEW

A NEW RESIN, Teflon, made by DuPont by polymerizing gaseous tetrafluoroethylene, has exceptional properties of resistance to heat and to chemicals and has already served in parts of jet propulsion engines, where it stood up under a temperature of 575 F, and has solved problems in radar and television. It was manufactured for special military uses during the war in a pilot plant at the Arlington, N. J. plant of E. I. DuPont de Nemours & Co., Inc. It is a thermoplastic.

Teflon is not affected by "aqua regia," one of the strongest acid combinations. In fact it stands attack of all materials except molten alkali metals, such as sodium and potassium. It is a good electrical insulator, especially against high electrical frequencies, having a low dielectric loss factor.

In addition to heat and chemical resistance, Teflon has low water absorption rate and high impact strength plus adequate toughness.

Let it be said here near the beginning that Teflon is still being produced on a pilot plant scale, though it is available for evaluation by customers as rods, tubes, sheets, heading, gaskets and thin tapes. Moldings of special articles will be undertaken if it is felt that a satisfactory product can be produced. No powder will be available for experimental work of any kind until techniques of fabrication are more fully developed and detailed information can be furnished to molders. Though production is from a pilot plant, this plant is much larger than one would normally expect. Most standard items are obtainable in from 10 to 14 days.

Pilot plant production of commercial quantities of this resin for war purposes was started in 1943 by the plastics department of DuPont. It is made by polymerizing gaseous tetrafluoroethylene to yield a solid granular polymer. The fluorine atoms in the molecule impart exceptional properties of resistance to heat and chemicals. In thin sections the resin is transparent but in thicker pieces it is waxy and white or gray in color. No colored forms of the resin have been developed but various inorganic fillers have been added successfully. The fluorine atoms apparently surround the carbon atoms effectively and prevent most forms of attack. Summing up its chief characteristics, Teflon has toughness over a wide range of temperatures, has excellent electrical properties over a wide range of frequencies, extreme chemical inertness and heat resistance.

Three rods of different plastics are being withdrawn from a sulphuric acid bath. The rod in the right hand of the laboratory technician is of Teflon. In the left hand a second standard plastic has deteriorated while a third standard plastic has swollen and become distorted.

Three types of plastic were tested on a hot plate at about 390 F. Teflon (right) is normal in all respects at that temperature.

It has no true melting point but undergoes a solid phase transition at 620 F, with a sharp drop in strength. Around 750 F it decomposes slowly to yield the gaseous monomer plus a few other gaseous fluorine derivatives. In fact, small amounts of fluorine-containing gases are given off at temperatures above 420 F. Since the toxicology of these gases is not fully understood, good ventilation must be provided for extrusion and other mechanical operations in which these temperatures may be attained. In the other direction of the temperature range Teflon can withstand down to minus 100 F.

Gaskets and wire insulation for jet engines are now made of this material because of its heat resistance. It is also used in aircraft ignition systems near spark plugs where ordinary insulators fail at high temperatures. Subjected to a temperature of 572 F continuously for three months in a recent test, it showed virtually no degradation, according to Dr. Malcolm M. Renfrew of DuPont. It retained all its useful properties at that elevated temperature. Since its heat resistance and aging properties are excellent immediate uses are suggested as a dielectric in the form of spacers in coaxial cable for color television and radar.

One of the important military uses was that by the Navy as a material in co-axial cable which extended from the deck of a fighting ship to the antenna mast. Usually, it had to pass close to the ship's smokestack. The Teflon held up well under the heat from the stacks whereas the polythene, previously used, also a duPont product, melted.

Chemical Resistance

As to chemical resistance such potent reagents as a mixture of hydrochloric and nitric acid; chlorosulfonic acid, acetyl chloride, boron trifluoride, hot sulphuric acid, hot nitric acid and boiling solutions of sodium hydroxide do not affect the polymer. No change in weight or properties results. No substance has been found which will dissolve or even swell the plastic except molten alkali metals. Hydrochloric acid systems, pump gaskets, high temperature heating systems, tubing and piping for chemical plants, distillation equipment for acids and all kinds of insulation are among the industrial applications.

One vulnerability of Teflon is fluorine gas. Thus prolonged exposure at 300 F will break Teflon down into carbon tetrafluoride.

The excellent electrical properties of Teflon, coupled with its heat stability, give it many potential applications in the power field, where one of the limiting features in design of electrical equipment has been the lack of suitable insulating material that will withstand high temperatures. Its resistance to surface arc-over is excellent and, on failing, it melts and vaporizes rather than carborizing, thus to leave a conducting path. The electrical losses in Teflon over a frequency range of 60 cycles to 3000 megacycles are substantially constant—and lower than those of polythene and polystyrene. It is an excellent insulating material for currents of ultra high frequency. It does not dissipate the electric power as do most

organic insulators when subjected to high frequencies.

Other Characteristics

Teflon has a water-absorption rate so low as to be rated "zero," high impact strength and toughness. It has self lubrication where used as bearings under a light load. It does not permit the "migration" of wire (or cutting through the insulation by the metal when under stress).

As an illustration of good non-"migration" qualities, various combinations of wires and insulating materials were bent around a 2¾ in. mandrel. From the free ends were suspended 50 lb. weights and the whole assembly heated to 455 F and held for 72 hrs. All other insulations except Teflon failed, that material having shown no migration either before or after the heat treatment.

In considering Teflon one naturally thinks of the Silicones (with silicon the key element) since they also stand up under heat and chemicals and have good electrical properties. DuPont engineers claim that the Silicones are more rubbery and are not as chemically resistant as Teflon.

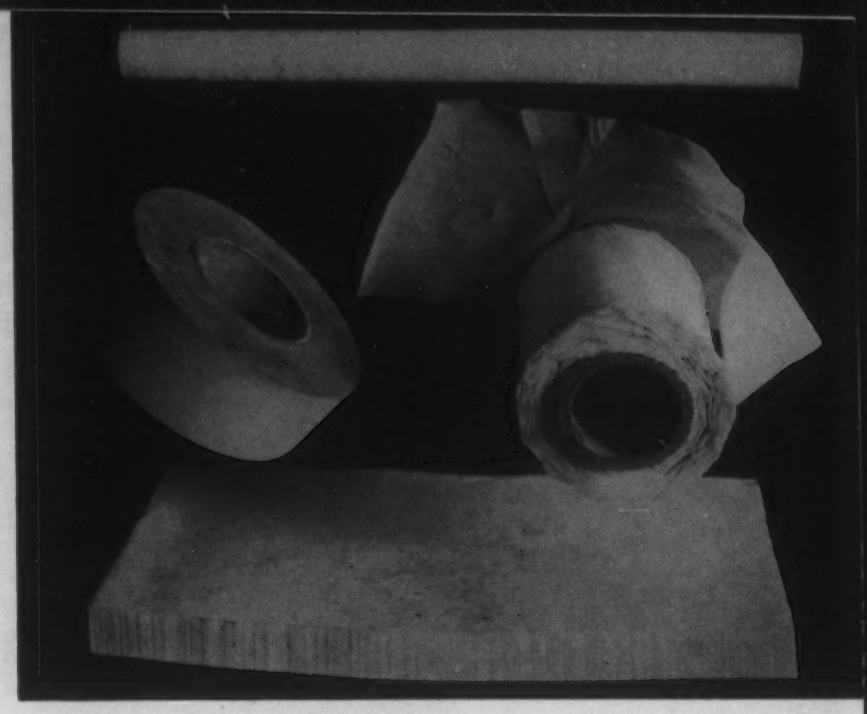
This polymer can be extruded in the form of rods and tubes or as a wire coating and compression moldings of simple articles can be made by using special techniques. Sheets and thin films are made by shaving blocks and cylinders.

Rods and tubes are extruded in continuous lengths by screw stuffers of the conventional type, although special techniques are required. To obtain the high temperature required for extruding, it is necessary to use electric heating pads regulated by controllers. Extrusion rates vary, but all are measured in terms of feet per hr. which is slow when compared with those of other thermo-plastics.

Wire is coated by using a crosshead die on a screw stuffer, with careful control of rates and temperatures —but again the rate is slow when compared with conventional wire-coating operations. Dip-coating methods may be feasible, but further development work will be required. In fact the manufacturer is quite frank when stating: "Difficulty in fabrication and high cost of manufacture are conditioning factors in the plastic's present stage of development."

Until molding techniques are more fully developed it is necessary to form articles of complicated shapes by machining some of the standard shapes of Teflon that are now available. It can be machined very easily with standard wood-working or metal-working tools as long as they are kept sharp. Sheet stock can also be worked on a punch press. Thin-walled tubing can be flared by standard flaring tools that are used for copper tubing, while heavy tubing can be threaded by standard pipe threaders.

Modifications of Teflon are under development to provide materials that can be molded on injection and compression machines with little difficulty. These will have good electrical properties and resistance to chemicals and heat. They are not available for evaluation but most of the experience gained with Teflon will be applicable to other members of the family of fluorine-containing resins.



Here are grouped Teflon items in forms of a rod, a cylinder, thick sheet and thin film.

Typical Properties of Teflon

Property	Test Result	Test Method
Specific gravity	2.1-2.3	D792-44T
Tensile strength at 77 F, psi.	2,000-4,500	[1] D412-41T
Elongation 77 F, %	300-400	[1] Die C
Flexural strength 77 F, psi.	2,000	[2] D650-42T
Stiffness 77 F, psi. (0.125-in.)	60,000	D747-43T
Impact strength, Izod, 70, 77, 170 F, ft.-lb./in.	2.0, 4.0, 6.0	D256-41T
Hardness, D. durometer	55	——
Compressive strength, psi. at 0.1% deformation	1,700	D695-42T
Yield temperature, deg. F	>320	Arl. M-8
Heat distortion temperature, low load, deg. F	266	D648(b)-44T
Specific heat cal./g./deg. C	0.25	[3] ——
Coefficient of expansion per deg. F (77-140)	5.5×10^{-5}	D696-42T
Thermal conductivity BTU/hr./ft.^{2}/deg. F/in. (0.18-in.)	1.7	[4] Arl. P-32
Brittleness temperature, deg. F	<−100	D746-43T
Dielectric strength, short time volt/mil (0.080-in.)	480	[5] D149-40T
Volume resistivity, ohm-cm.	10^{16}	D257-38
Dielectric constant 60, 10^3, 10^6, 10^8 cycles	2.0	D150-40T
Power factor 60, 10^3, 10^6, 10^8 cycles	<0.0002	D150-40T
Water-absorption, %	0.00	[6] D570-42
Moisture permeability g./meter^2/24 hr.	0.00-0.5	D697-42T
Outdoor weathering	No detectable change in 1 yr.	

(Data given represent standard commercial grades of material and standard methods of the American Society for Testing Materials for testing, except where otherwise noted)

[1] *Tensile strength in oriented film may be as high as 15,000 psi.*

[2] *Specimens do not break*

[3] *Method of mixtures*

[4] *Cenco-Fitch apparatus*

[5] *1,000-2,000 volt/mil in 5 to 12-mil thickness*

[6] *Not wet by water*

Heat-Treated Rivets for High Strength Joints

by N. L. MARVIN, *Pheoll Manufacturing Co.*

RIVETING AS A MEANS of permanent assembly offers many advantages, such as ease and speed of operation, use of a minimum number of parts, and rigidity of assembly. Riveting has been particularly favored in aircraft construction, where thousands of aluminum alloy rivets are used in fabricating aluminum skin for wings and fuselage.

A disadvantage of riveting is that the process, by its nature, limits the fastener to materials relatively easy to deform, and so of comparatively low strength. This is overcome to some extent in the case of aluminum alloy rivets by driving the solution-treated rivet immediately after removing it from cold storage and allowing it to age in position. Use of steel rivets of the conventional type, but of such composition as to make possible the high strengths obtained in other applications, has not been practicable, since cold driving engenders cracking and hot riveting leaves final physical properties in question.

A wartime development in the aircraft industry has overcome this limitation. An alloy steel rivet has been devised that permits heat treating to high strength of the load-carrying part of the rivet, and of cold swaging an aluminum alloy collar into place to complete the fastening. The aluminum collar permits the deformation necessary for riveting, and the heat-treated body of the rivet is not altered by the operation.

This type heat-treated rivet was developed by engineers of North American Aviation, Inc., to meet the need for a fastening of high strength and low weight for critical locations in airframes. Its success led to adoption by most manufacturers for use with engine mounts, wing spars, vertical and horizontal stabilizers, firewalls, and similar assemblies. Used originally for military aircraft, it is now going into commercial planes, automobile truck trailers, and other civilian items. Patents are held by North American Aviation, Inc.

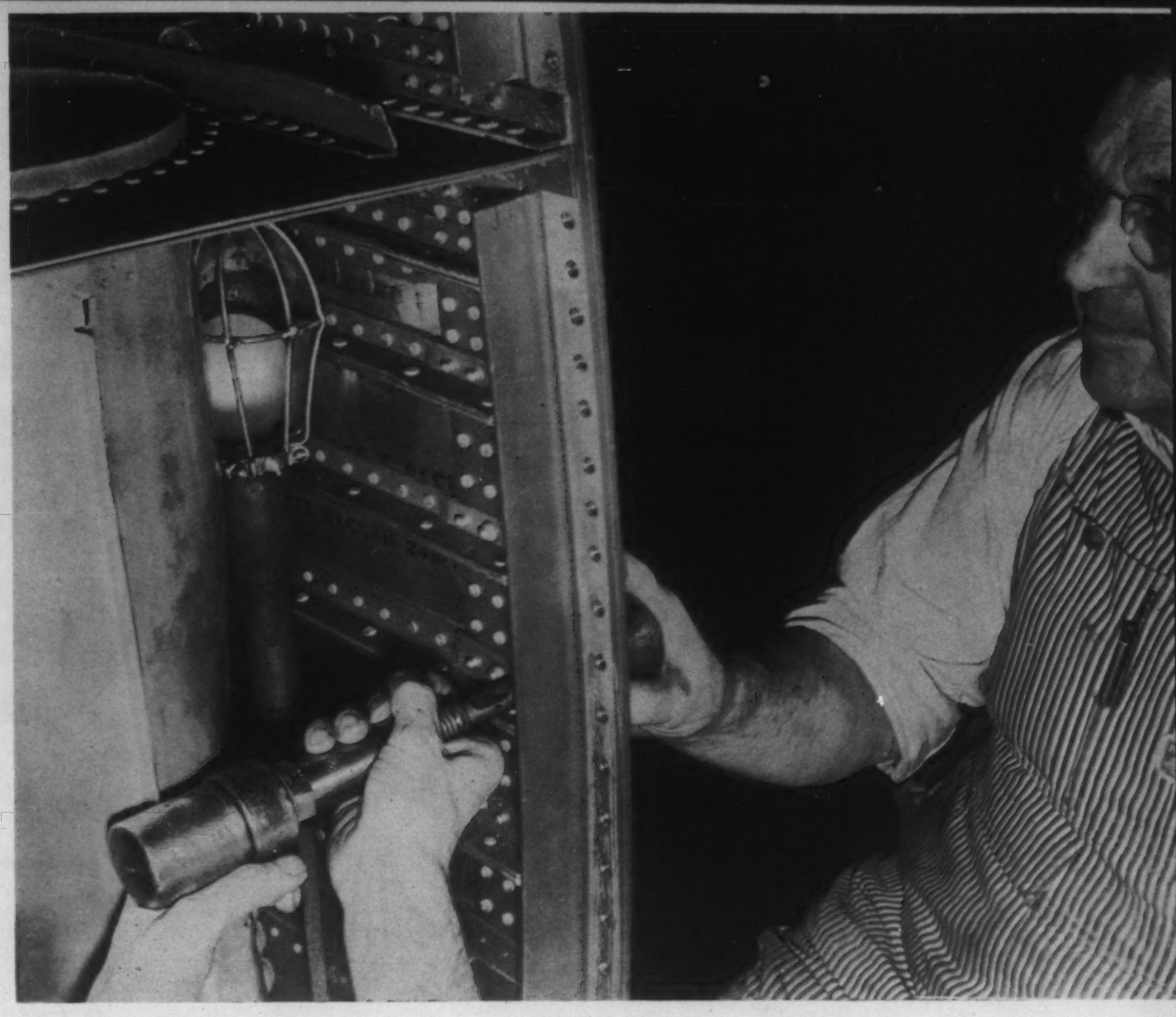
The rivet consists of an alloy steel pin, headed at one end, and with a groove and cutting edge machined in the other, and an aluminum alloy collar which fits over the grooved end of the pin. The pin is made of A4037 steel, ordinarily, although it can be supplied in stainless steel if desired. It is cadmium plated to provide corrosion resistance. The collar is A17ST aluminum, anodized to increase corrosion resistance, and waxed to facilitate swaging under the riveting gun. The alloy steel pin is heat treated to a tensile strength of 125,000 to 150,000 psi. The rivet is designed primarily for high resistance to shear, which is the controlling stress in most riveting applications. Using the tensile strength of 125,000 psi. as a working minimum, shear strengths of 75,000 psi. would be developed, and this value is used for design purposes.

Collar Undergoes Deformation

Because the relatively soft aluminum alloy collar is the only part of the rivet to undergo deformation during the riveting process, lightweight equipment can be used for even the larger sizes. The ordinary riveting gun is fitted with a special set differing from the usual rivet upsetting tool only in the design of the collar swaging recess, and in having a discharge port through which the trimmings from the collar are ejected. When rivets are to be placed near the edge of the work, a squeezer device can be substituted for the gun. Reverse riveting can be resorted to when the collar end of the rivet is inaccessible, and for this purpose a special bucking bar is available. The gun is then applied to the head of the rivet.

Using the heat treated rivets, which are offered under the trade name "Hi-Shear," consists simply of dropping the pin into the rivet hole, slipping the

Combination of heat-treated alloy steel body and deformable aluminum collar provides new-type rivet with the high strength needed for many applications.



Here Hi-Shear rivets are being driven on an airplane part. This difference in appearance between these and ordinary rivets can be seen readily.

aluminum collar over the grooved end and, with a bucking bar supporting the head end of the pin, swaging the collar into the groove. As for any riveting application, it is important that the work pieces be securely clamped or otherwise held together. Installation is reported by the aircraft companies to be from three to five times as fast as with the bolts they replaced, and to show a weight saving of more than 50% over alloy bolts, washers, and nuts formerly used for many critical locations. The cost is also considerably lower than that of the alloy bolt, washer, and nut combination.

Because the aluminum alloy will compensate for irregularities in the surface of the work to a considerable extent, spot facing and use of shims or washers can be reduced or eliminated. Inclination from the perpendicular of as much as 7 deg. will be compensated by the collar without other adjustment. The same adjustment takes place with cylindrical work, unless the radius of the surface is more than three times the diameter of the pin.

Selection of rivets of the proper length is important, since the holding ability of the rivet in tension is dependent upon correct formation of the swaged collar. The cutting edge of the groove which serves to trim off excess metal from the collar during riveting, should be 1/16 in. below the top of the collar. If the cutting edge is higher than this, the aluminum will not fill the groove completely, and if lower, the riveting set will not contact the cutting edge to trim off the excess metal. Variation of 1/16 in. is allowable.

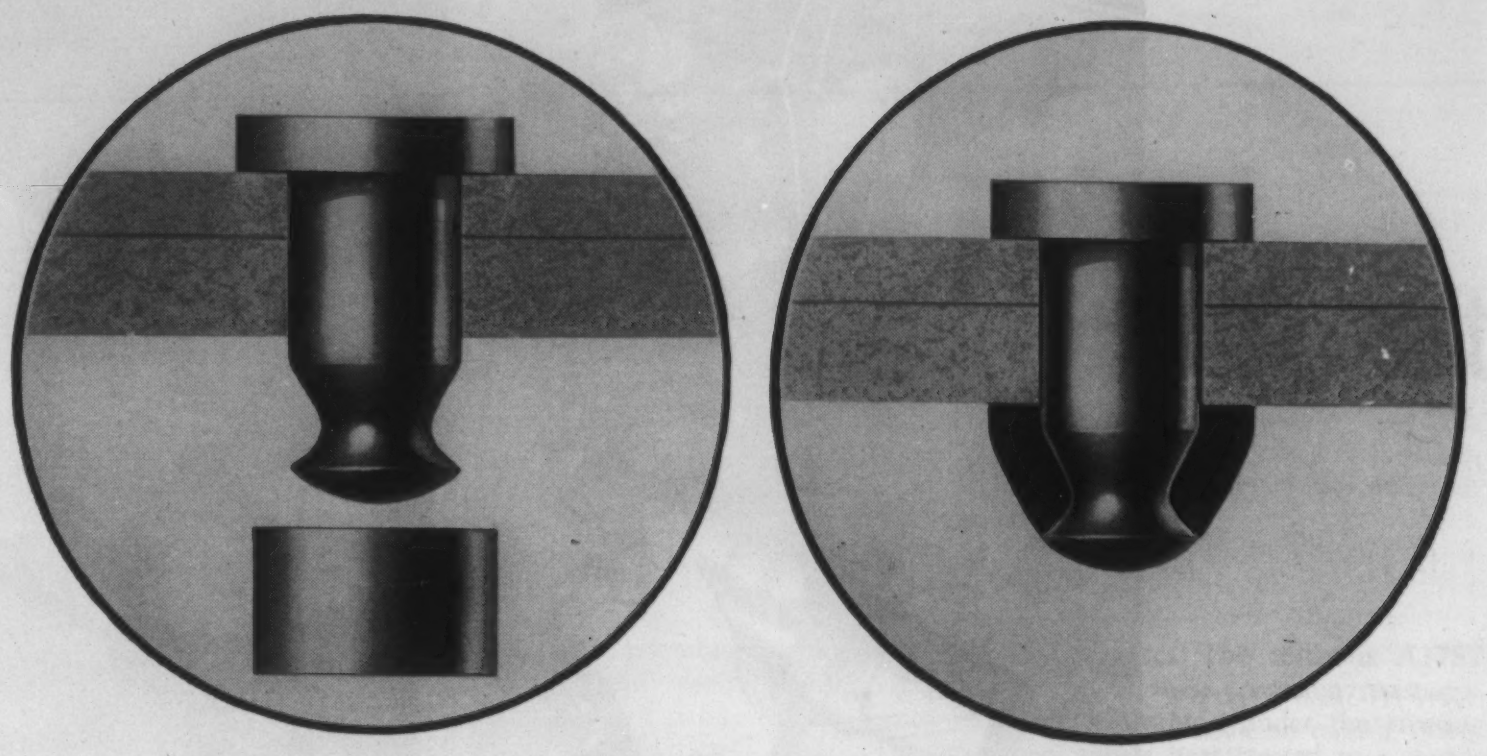
Removal of the rivets can be accomplished easily without damaging the work. The pin end can be drilled off by using a drill slightly larger than the diameter at the root of the groove, with a drill-out bushing to position it. Splitting the collar, if done carefully, will permit reuse of the pin also. A narrow cape chisel can be used to cut through the collar on opposite sides, or the same effect can be achieved by use of a hollow punch having one or more inside cutting edges, or with special nippers. Any of these methods, if carefully used, will remove the rivet without enlarging the hole. When necessary, removal from the head side can be accomplished by using a drill of the pin diameter in connection with a drill-out bushing.

Hi-Shear rivets are made to close tolerances. Sizes at present available are 3/16-, ¼-, 5/16-, ⅜-, 7/16-, ½-, 9/16-, ⅝- and ¾-in. pin diameters, and various grip lengths. Hole size follows the practice for aircraft bolts, with the following considered good practice:

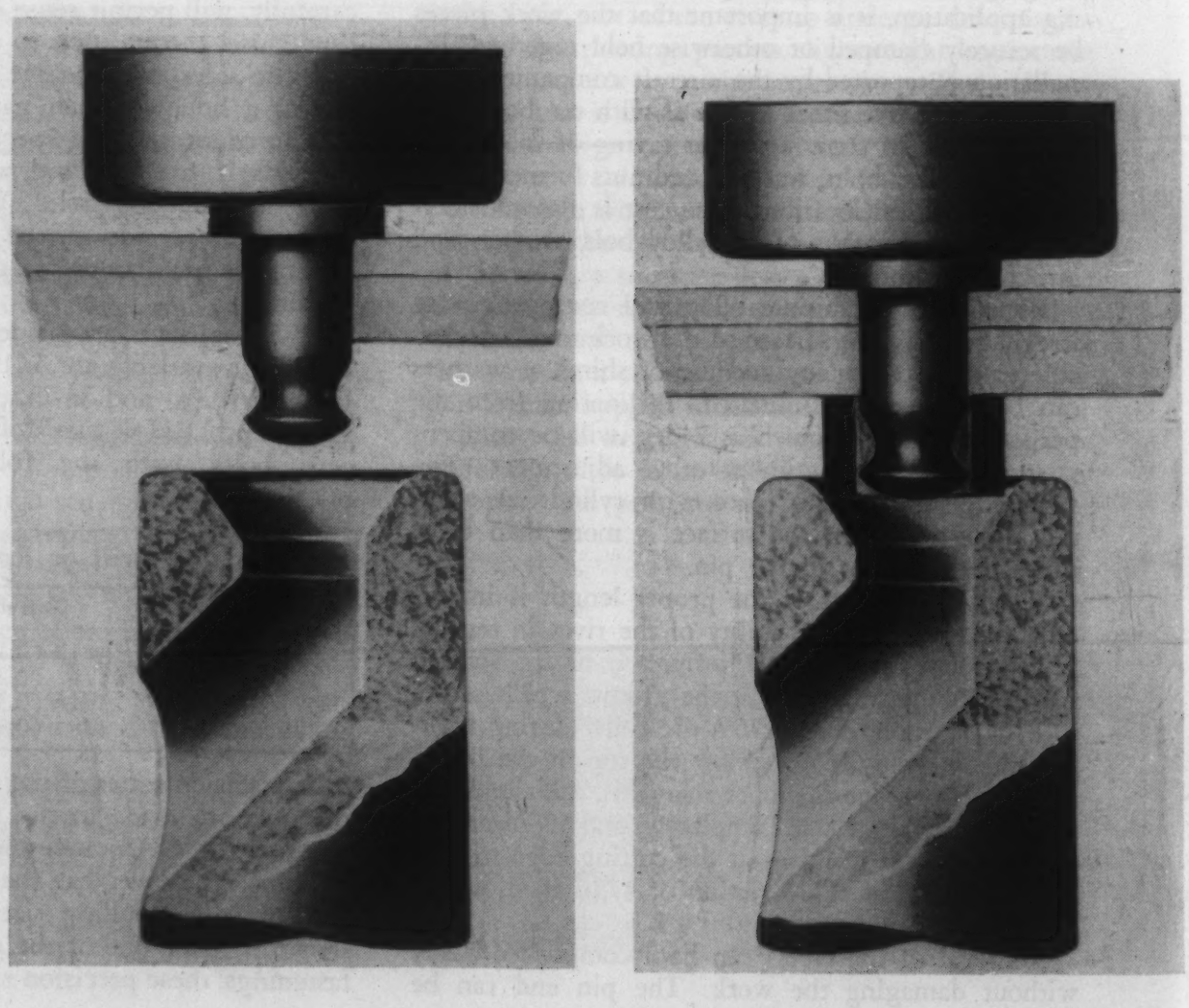
Drill or Ream Sizes

Rivet size	Drill size	Ream size
3/16 in.	#12 (0.189)	0.1900 ± 0.0005
1/4 in.	1/4 (0.250)	0.2500 ± 0.0005
5/16 in.	5/16 (0.3125)	0.3125 ± 0.0005
3/8 in.	3/8 (0.3750)	0.3750 ± 0.0005

A precision series of the rivets is available in which the pins are made to the same diameters and tolerances as the NAS close-tolerance bolts +0.,—0.0005 in. Since the rivet has the same shear strength as a bolt of corresponding size, and wartime uses have shown it to be one of the most vibration-resistant of fastenings, these precision rivets can compete on equal



In these two photographs are "before and after" views of the new type rivet. That portion of the aluminum collar which remains after the rivet is driven is sheared off to form a smooth head.



From left to right are shown the steps in completing a Hi-Shear riveted joint. First the pin is dropped in the work, next the aluminum collar is placed on the pin and then the collar is swaged to complete the joint. Finally, the extra collar material is sheared off.

terms with bolts in the matter of strength, and offer considerable advantage in weight and installation time.

Accurate sizing of the rivet hole is important, as the pin of the heat-treated rivet, unlike those of softer materials, will not expand to fill an oversize hole. A light tap fit is sufficiently snug, and diameters 0.004 to 0.005-in. over the nominal are about the maximum permissible for highly stressed structures.

The rivet sizes are set down according to a code, in which the head style is followed by a dash number indicating the nominal pin diameter in 1/32ths, and by a second dash number indicating the maximum grip in 1/16ths. Three head styles are available—a 100-deg. flat countersunk head, designated as NAS 177; a flat binding head, NAS 178, and a brazier head, 2R5 in NAA standards. Thus, a part number NAS 178-10-18 would indicate a rivet with flat binding head, 5/16-in. pin diameter, and 1⅛-in. maximum grip. The collar is designated as NAS 179, and is sized by diameter only.

Manufacture of the rivets under North American Aviation license has been going forward during the war, with the entire output channeled into the aviation industry. There are four manufacturers licensed to produce this type rivet: Pheoll Mfg. Co., Chicago; National Screw and Mfg. Co., Cleveland; American Screw Co., Providence and Fibre and Metal Products Co., Downey, Calif. Alloy steel rods are cold headed, then machined on semi-automatics to cut the groove into the pin with the requisite accuracy. Heat treating in a continuous heat treat furnace, with controlled atmosphere, gives the required physical properties, with a minimum tensile strength of 125,000 psi. developed. Electrodeposition of 0.0002- to 0.0005-in. of cadmium completes the pin, and provides satisfactory corrosion resistance for ordinary applications.

Stainless Steel Pins Used

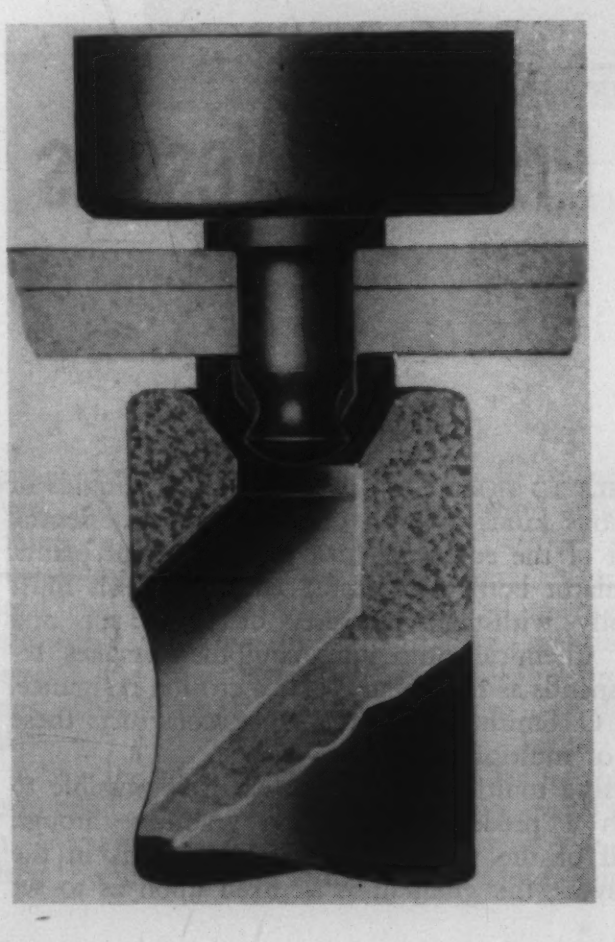
Pins of stainless steel are used in aircraft assemblies where their nonmagnetic qualities are important. They can be specified also where temperature resistance is required. While the pins of A4037 steel will give satisfactory service at somewhat elevated temperatures, the pins of the stainless material, when placed so that the head end of the pin is on the hot side, will perform well at considerably higher heats.

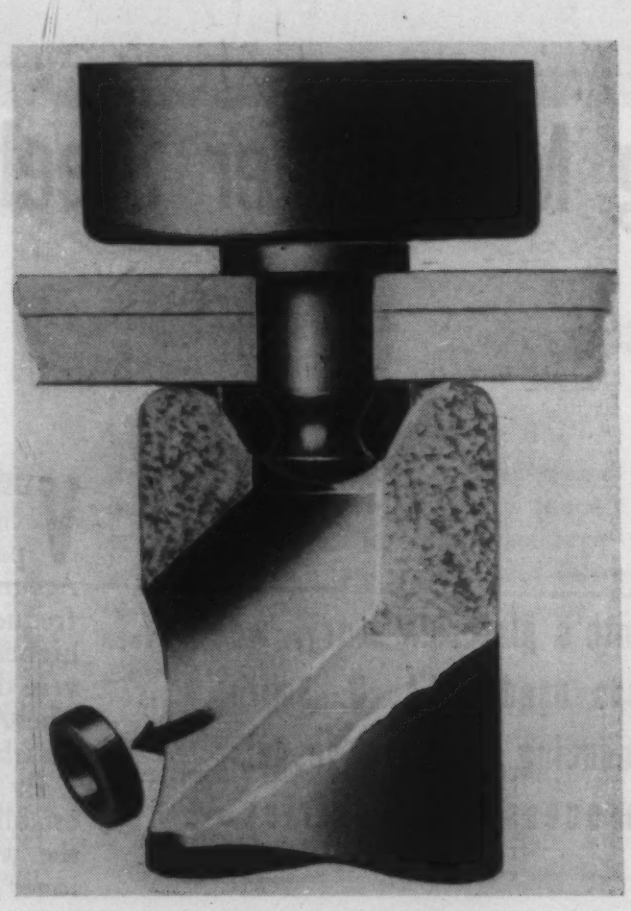
The aluminum alloy collars can also be supplied in bright Alumalite colors when desired for decorative purposes, as in aircraft interiors.

Because the pins in the Hi-Shear rivets do not expand during the riveting process as do those of the conventional type, they are especially suited to fastening soft materials such as plastics, wood, and soft metals. The rivet is faster than bolting, and does not tend to crack or deform the base materials.

The same advantage holds for riveting in which the pin must pass through hollow sections which offer it no support, and in which rivets of the ordinary type tend to bend upon driving.

The easy removal of the rivet by splitting the collar makes it of value as a fastening for cases around mechanisms that should be serviced only by authorized personnel. The rivet makes an excellent "tamper-proof" device.





1 *In fabricating multi-layer vessels, each layer is rolled from flat plate to a predetermined radius.*

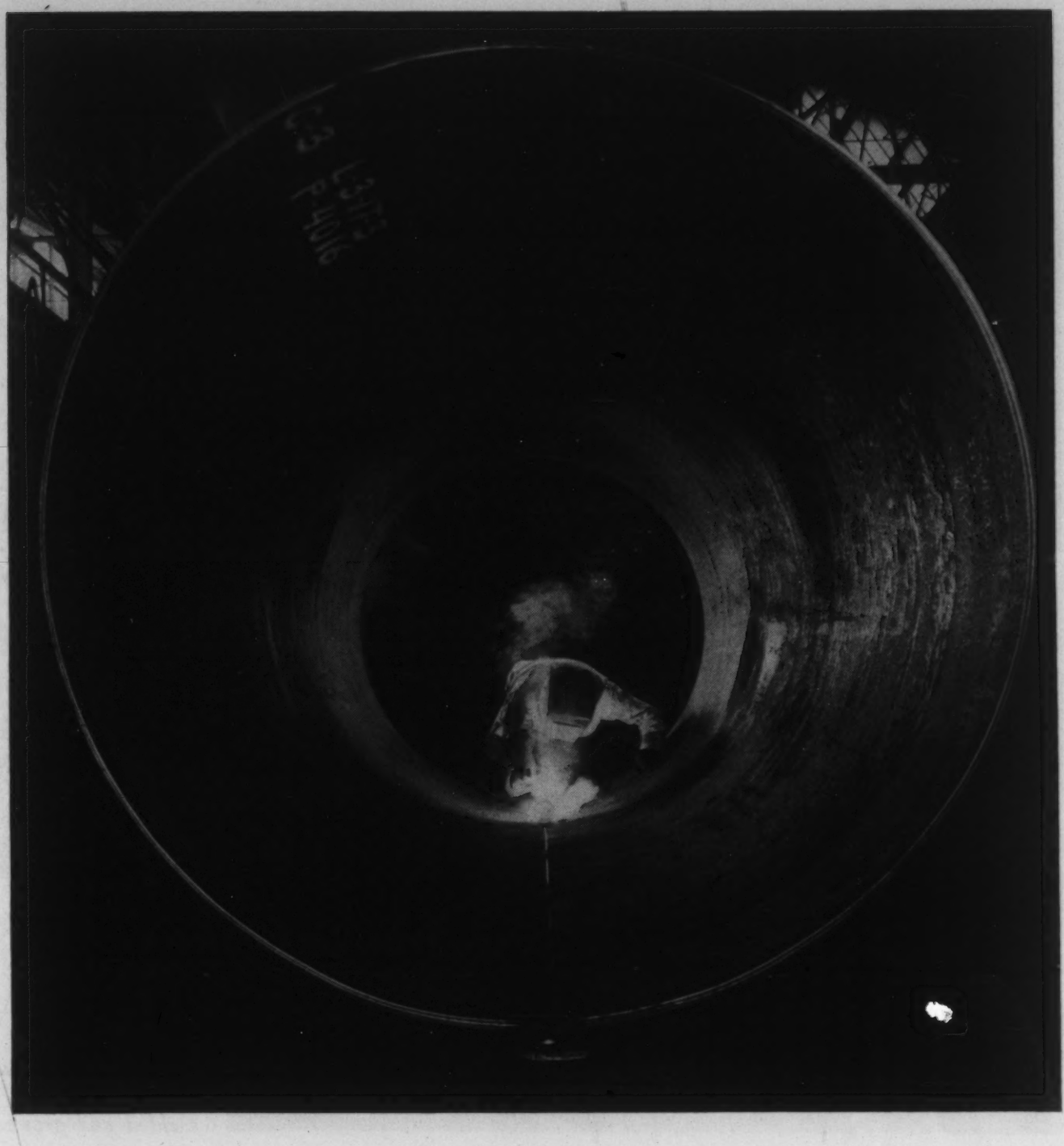
Welding Multi-Layer Steel Pressure Vessels

—A Pictorial Story

As this month's pictorial story, we show methods used by A. O. Smith Corp. in producing pressure vessels for many processing industries.

VESSELS TO HOLD AIR or other gases, or liquids of various kinds at high pressures are an essential part of the equipment for many types of plants. Accumulator bottles for stored energy systems must frequently withstand pressures of 5,000 psi. and higher. Chemical processing equipment makes severe demands as to pressures and corrosion resistance. The A. O. Smith Corp., Milwaukee, constructs these vessels of multiple layers.

By using multi-layer construction it is possible to establish a predetermined stress gradient through the wall of the vessel. Since failure begins in the inner layers, the gradient is so fixed upon as to set



2 *Inner and outer surfaces of the seam of the first layer are arc welded.*

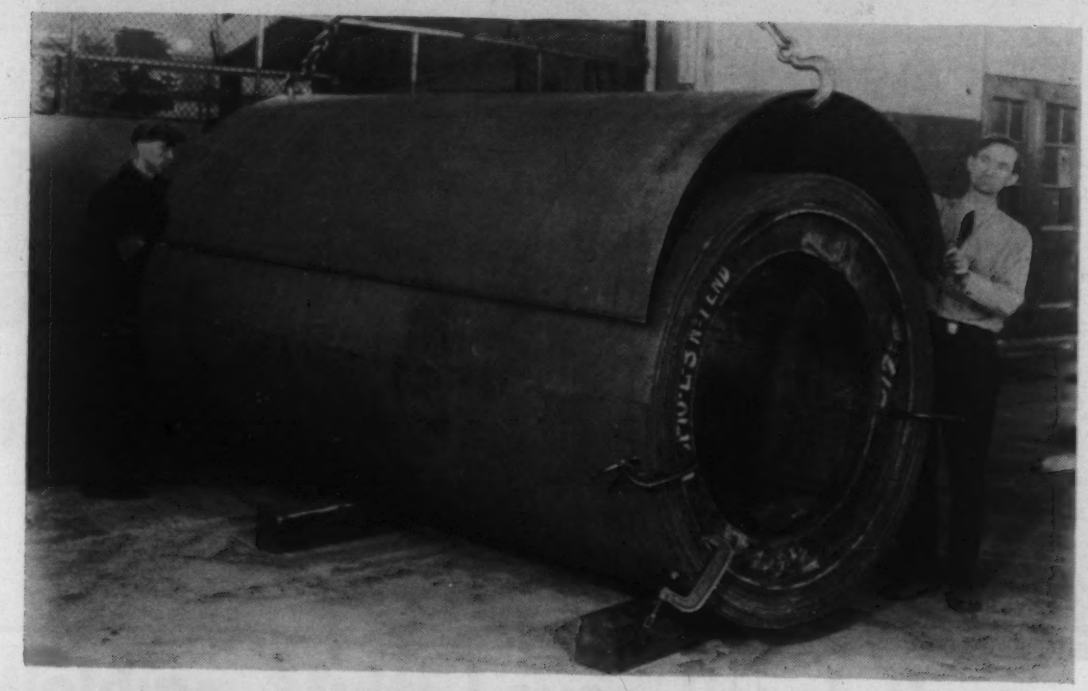
up an initial compressive stress in the innermost layers, the gradient passing through zero, and into tension in the outermost layers. In service, stress reversal must occur in the inner layers before the metal can be subjected to tension, so raising the permissible working pressures before the tensile stress in the inner layers reaches dangerous proportions. This principle is used in modern gun design also.

When the mutli-layer vessels have been tested to destruction, it has been shown that they break without shattering, a series of tears through the steel plates permitting the release of pressure. Similar tests upon cast vessels, when carried to destruction, result in a shattering of the piece. Greater safety is indicated with the multi-layer type of construction.

Use of steel plate and welded fabrication also permits closer control over the quality of the materials. Uncertainty regarding possible deep-seated flaws is eliminated.

A large field for the use of presssure vessels is in the chemical industries. Here multi-layer construction possesses the advantage of permitting a "cladding," in that the innermost layers may be of a corrosion-resistant steel rather than of the mild steel usually used. —K. R.

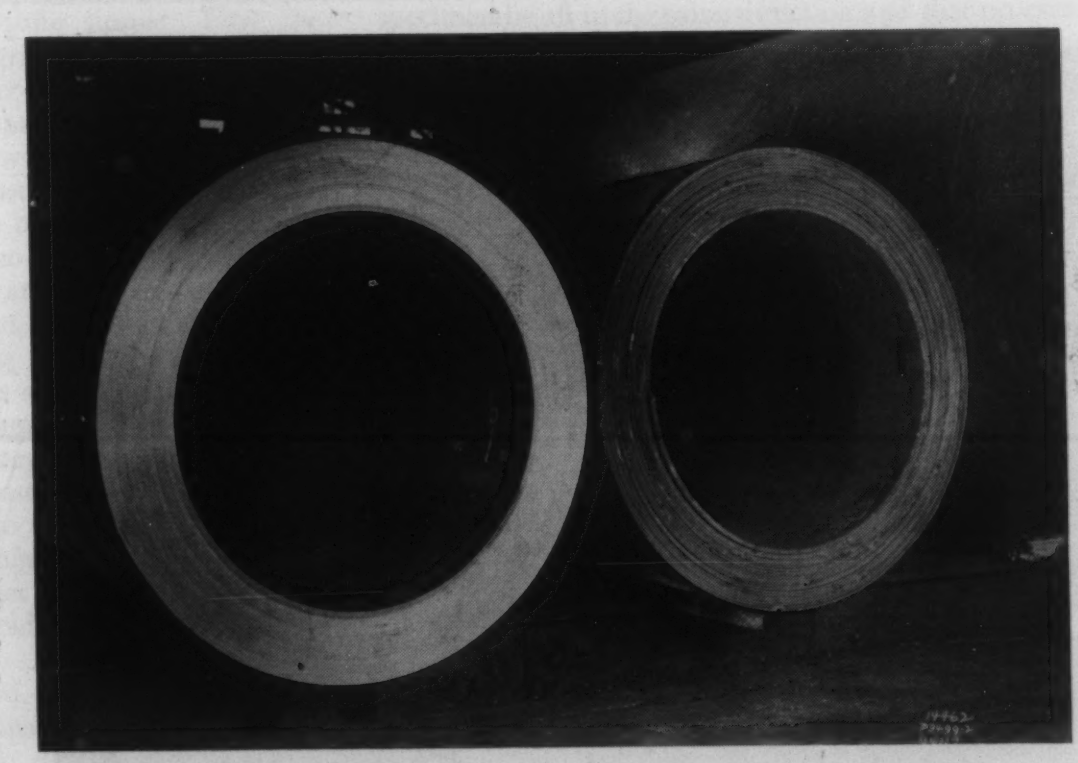
3 *A carefully calculated compressive stress is applied to inner layers by woven steel bands drawn about the bent sheet preparatory to welding.*



4 *Layers are built up one at a time, each assembled, welded and ground.*

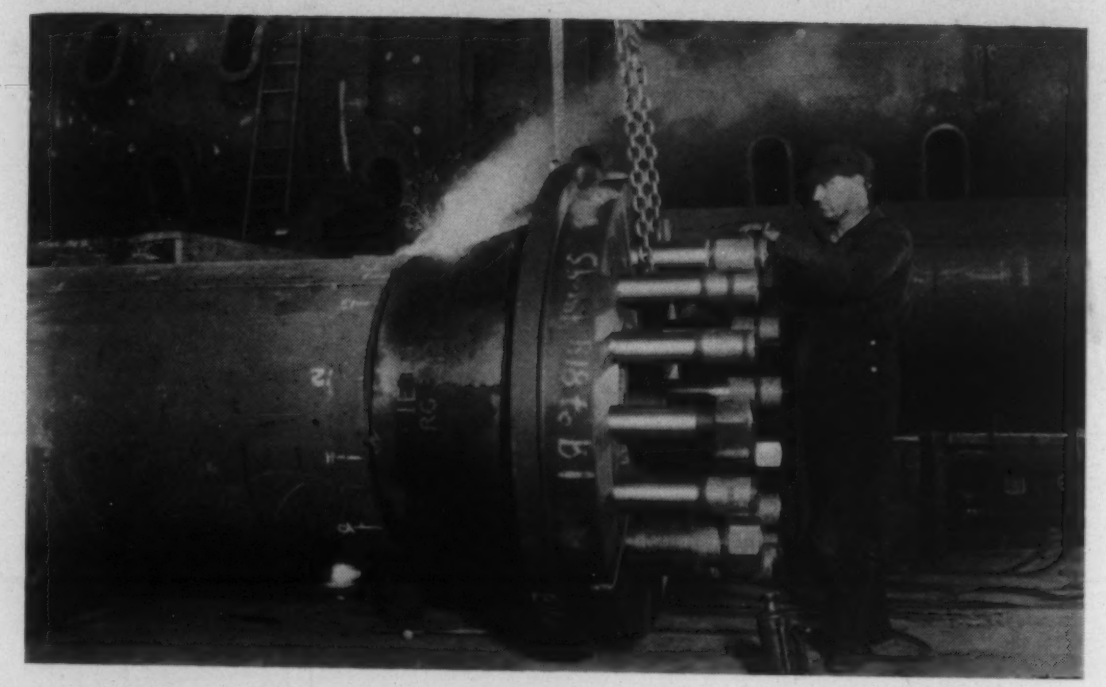
5 *While the wrapping machine holds the last layer tightly in place its edges are tack-welded.*

6 *Removed from the wrapping machine the layer is now seam-welded. Cooling will further compress the inner layers.*

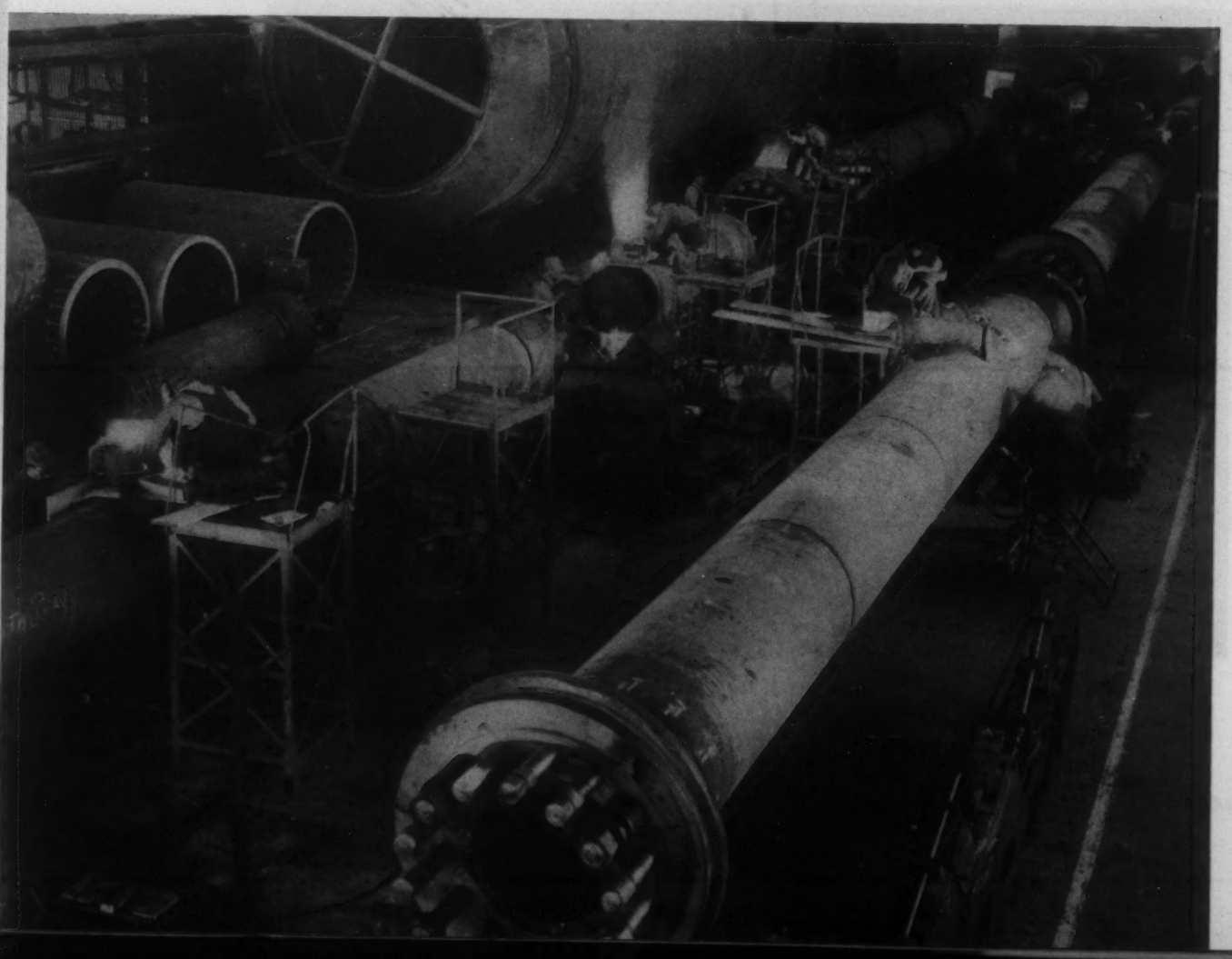


7 *After welding and grinding the last seam, the end of the unit is scarfed to provide for welding to the head, or to another section.*

8 *Long units are made by welding together two or more sections.*



9 *The head is tack-welded to the unit, preparatory to final welding.*



10 *Final assembly of the units. Brackets are welded into place, bottoms are welded on.*

Samples of pure metal or their alloys can be prepared for examination in a few minutes by unskilled workers with ordinary cloth buffing wheels.

Polishing a metallographic sample

A Simple, Fast Metallographic Polishing Method

by R. B. McCAULEY, JR., *Illinois Institute of Technology,* and L. F. MONDOLFO, *Reynolds Metals Co.*

IN A RECENTLY PUBLISHED book, one of the authors has described a new buffing method for the rapid polishing of aluminum alloys. By this method it is possible to prepare a specimen for micro-examination in less than 5 min. in even the most difficult cases.

Since the method has proved successful with pure aluminum and soft alloys, which, as a rule, are difficult to polish as, it was decided to investigate its possibilities with other metals and alloys.

The means of polishing which are to be described have been successful with most metals tried, so before describing and showing the results, it might be best to give a full description of the method used.

The polishing is really quite simple. First the specimen is made flat by grinding, filing, sanding, turning in a lathe, or by other means, then the coarse grits of the planing are removed by washing and drying. The specimen is now held against a buffing wheel heavily coated with paste. Speeds of the wheel are not critical. Speeds have been used varying from 3,000 to 6,000 r.p.m. with no appreciable difference. Disks of unbleached muslin are used, ranging in size from 8 to 12 in. in dia. and thicknesses of 1-in. or greater. Commercial buffing pastes are used, with pastes containing alumina as a grinding agent seeming to be the best. Alundum paste can be used if buffing is followed by a magnesia polishing stage. It is advisable to have a paste with a low melting point to enable the paste to act as a lubricant and prevent dragging. In polishing, heavy pressures are used at first and specimens get rather warm to handle. Thus pliers are used to hold the specimen during polishing.

When the buffing is started, high pressures are used and the specimen is held so that scratches produced by buffing are perpendicular to those produced by the preceding flattening operation. When evidence of the first preparation has disappeared, the specimen is rotated 180 deg. and is held lightly against the wheel until it is brilliant and most of the paste has been removed. If the specimen contains hard constituents in a soft matrix or has porosity pinholes, it is advisable to do the final polishing with a 90-deg. rotation, rather than 180-deg., to prevent drifting or comet tails. In severe cases of porosity, it may be expedient to rotate the specimen continuously during the first polishing so as to avoid directional polishing and then finish with a longer period of buffing with light pressure and only one direction of buffing.

Care must be taken that scratches in the finished specimen be all in the same direction and that no cross scratches be present. If the scratches are all in one direction it is possible, by rotating the specimen under a microscope, to find an orientation of the specimen with respect to the beam of light, in which the scratches appear to be greatly reduced.

Following buffing and before examination, the sample is washed in some detergent liquid such as alcohol, acetone or carbon tetrachloride to remove the greasy paste from the specimen. To wash, absorbent cotton is dipped in the liquid and the surface of the specimen is swabbed in the same direction as the last polishing to prevent cross scratching.

The buffing has some tendency to round corners and edges of specimens, so where the edge must be examined, as in coated materials, this method of polishing is unsatisfactory unless the outer edge can be built-up by electrodepositing another metal on its surface or by clamping the metal surfaces together tightly. The same rounding is noticeable with soft mounts, fusible metal mounts or thermoplastic mounts. Thermosetting plastics, if mounted with high pressure, show much less tendency to rounding.

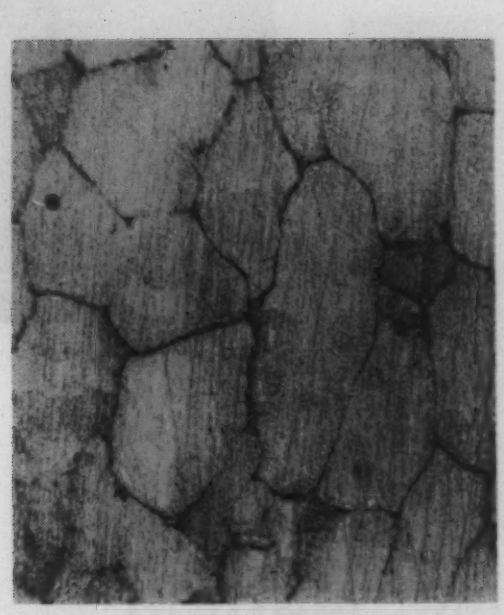


Fig. 1—Pure tin, as cast, etched with diluted hydrochloric. Grain boundaries are clearly visible. (X 250.)

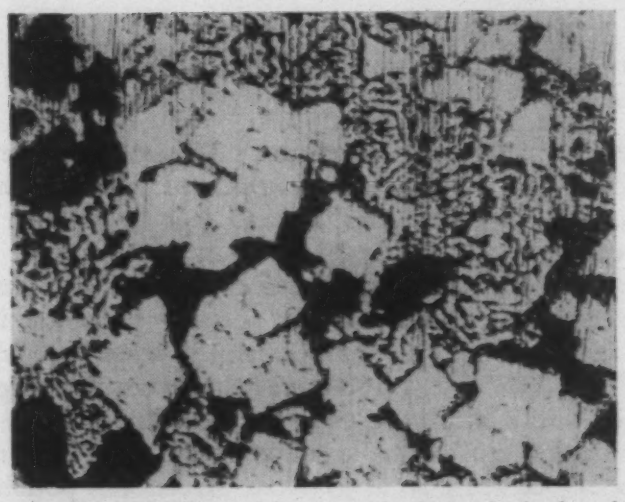


Fig. 2—Lead-base babbitt, etched with hydrochloric antimony-tin primary crystals and eutectic are clearly defined on the lead background. (X 250.)

Fig. 3—Dowmetal H as cast, etched with 1% nital. Manganese particles are round, gray; aluminum-magnesium-zinc is reprecipitated as perlitic structure, eutectic aluminum-magnesium-zinc shows as white particles. (X 500.)

Results on Various Samples

The first specimens tried were pure metals which usually are more difficult to polish than alloys. Fig. 1 shows pure tin, and is representative of the results obtained with pure metals. Among those polished were copper, lead, magnesium, bismuth, antimony, tin, and zinc. While the samples show some scratching, they do not show any evidence of deformation or surface flow. Copper and magnesium for example, are readily susceptible to twinning in polishing. These materials, polished by buffing did not show any evidence of strain bands or twinning. Similarly antimony and bismuth surfaces tend to show fragmentation in normal grinding. The specimens prepared by this method showed a complete lack of fragmentation.

Next, materials with dissimilar structures were tried, that is, specimens with soft matrix and hard particles or with hard matrix and soft particles. Tin and lead babbits, magnesium alloys and high antimonial lead were polished and examined. Without exception, normal structures were obtained. Fig. 2 shows a lead base babbit. Sharp corners of the hard and brittle antimony-tin compound can be observed as clearly defined cube structures, also the ternary eutectic structure can be clearly detected. A magnesium base alloy in the cast condition is shown in Fig. 3. The lamellar structure of the reprecipitated aluminum-magnesium-zinc compound is sharply defined, so is the directly solidified ALMgZn compound. In both cases the structures are scratched, but not in a way to detract from the clearness of the structure.

Various leaded brasses and cast iron were chosen as examples of materials with soft constituents and hard matrix. Fig. 4 shows a leaded brass. The lead particles both large and small are sharply defined and have remained in their original position. In no sample was the soft constituent pulled away from the harder matrix. While the structure of gray iron was very satisfactory with well defined graphite flakes, a long period of polishing was required to remove grinding scratches from the matrix. A satisfactory polish could not be accomplished within 3 or 4 min., but from 7 to 10 min. of buffing were required.

In view of the trouble encountered with the harder gray iron, the next step was to try some of the harder nonferrous alloys such as beryllium bronzes, high tin bronzes, nickel silver, manganese bronzes, etc. All of these could be polished satisfactorily in two to three minutes. Fig. 5 shows a cast alpha-beta bronze. The filigree of the beta constituent is clearly visible, for the scratches present do not detract from the clearness of the structure. Fig. 6 shows a cold-drawn cartridge brass, after annealing. In this case the lead particles, because of the etching used to reveal the grain size, are corroded and appear as black spots.

Quite often customary polishing procedures, which require polishing with water, destroy the possibility of obtaining the characteristic constituent colors. The longer the polishing procedure, the less chance there is of preserving these colors. On the contrary, the buffing method, which does not require water and is very fast will preserve the original colors. Fig. 7

Fig. 4—Leaded brass, etched with diluted hydrochloric. Lead particles show dark gray, clearly defined and slightly in relief. (X 1000.)

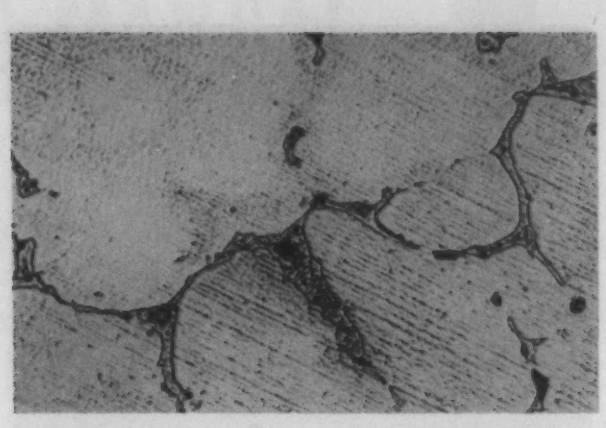


Fig. 5—Alpha-beta bronze, etched with ferric chloride ($FeCl_3$). Beta constituent appears as filigree. (X 250.)

Fig. 6—Cold drawn cartridge brass, annealed, etched with ferric chloride ($FeCl_3$). Grain structure clearly visible, the small black spots are lead particles. (X 100.)

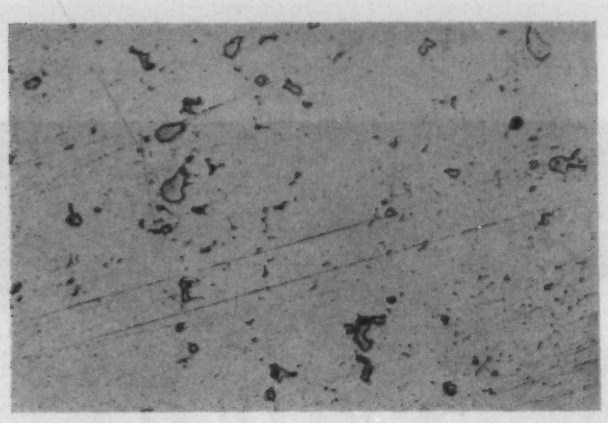


Fig. 7—Leaded bronze, not etched. Lead particles are well defined, slightly in relief and have the light color of freshly cut metal. (X 100.)

Fig. 8—Magnesium alloy containing silicon and iron, not etched. The sharply defined crystals are magnesium silicide (Mg_2Si), the small needles are iron. Note light color of Mg_2Si. (X 250.)

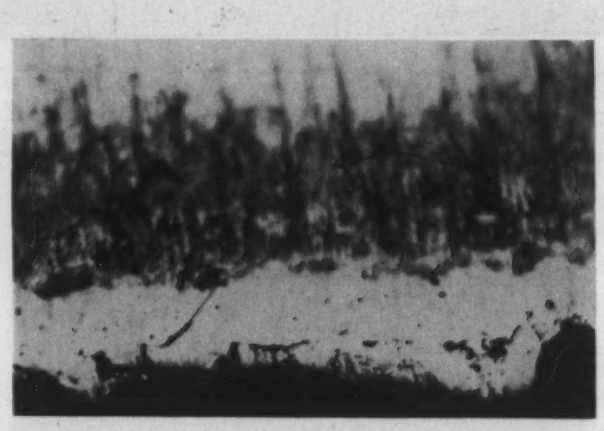


Fig. 9—Tin coated copper—Polished by normal methods, not etched. Notice dark stain on the copper near the tin. (X 500.)

shows a leaded bronze, unetched. In this specimen the lead particles do not have the dark dull color of oxidized lead, but the silvery color of the freshly cut metal. A more striking example is shown in Fig. 8. This is a sample of magnesium base alloy, with an abnormally high silicon content. The magnesium silicide which is present, when polished by buffing, will show a bluish-gray color, which in the photograph will show as light gray. If the same sample is polished by normal methods, the magnesium silicide will be colored from dark blue to black and, if the polishing is protracted, it will be corroded and the boundaries will lose their sharpness.

Other materials difficult to polish are plated or coated materials. The conventional method of polishing requires at least one step with abrasive suspended in water. In coated materials there is usually a difference of potential between the two metals, which in

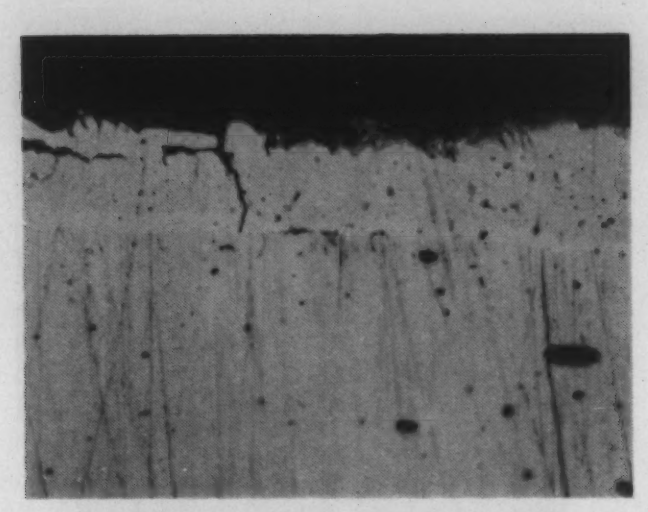


Fig. 10—Same material as Fig. 9—Buffed but not etched. The intermediate layer at the bond zone is clearly visible. (X 500.)

Fig. 11—Aluminum-silicon alloy, slowly cooled in the crucible. Sharp boundaries of shrinkage cavities and of primary silicon crystals are clearly shown.

Fig. 12—Dowmetal H, heat treated, not etched. The sample has been polished improperly and not washed, to show the distinctive comet tails which are formed when samples containing hard particles or porosity are not polished properly. (X 250.)

presence of water, will produce selective corrosion.

The buffing method does not require any contact of the sample with water; therefore, the staining or pitting produced by the electrolytic corrosion is avoided. Fig. 9 shows a sample of copper plated with tin polished by conventional methods. Although the polishing on the final wheel has not been protracted to the extent of removing the scratches completely, there is a stain in the copper, near the tin, which masks the bond zone. Fig. 10 shows the same material polished by buffing, in which no stain is produced and the presence of an intermediate layer at the bond zone is clearly visible.

Advantages of Method

The outstanding advantage of this method of polishing is the speed of operation. On the average, no more than 2 to 3 min. polishing time is required. It is not at all uncommon for the students in the laboratory to polish specimens in less than 1½ min. This speed comes rapidly to the beginner, who, after polishing but few specimens is quite proficient with this polishing method. Most conventional polishing not only takes quite a while to perform, but requires quite a training period to enable the beginner to prepare specimens with any measure of success.

Another advantage of this method is that it does not require small specimens. Specimens as large as 3 to 4 in. have been handled successfully. Often in castings, forgings, welds, etc., examination of an extensive area is required, to show gradual structure variations. This method does not require sectioning of the parts, but can handle a wide size. In addition to microstructural examinations, macrostructural specimens may be sawed and polished directly, for an unusually fine macro-polish can be obtained faster or as fast as other methods, yielding coarser surfaces. Fig. 11 shows a specimen prepared for macroexamination.

A third advantage is the possibility, after polishing by buffing, to pass the specimen in an alumina or magnesia wheel, and obtain a surface preparation which is as good, if not better than that obtained by the ordinary polishing method. Even if this final polishing is used, the method permits still a saving of time, since the grinding on papers of decreasing grit size is completely replaced by the buffing. Moreover this method permits one to examine, in a very short time, several specimens from the same sample, select the most interesting one and polish it to obtain a surface that is free from scratches and suitable for photography.

As already mentioned, the buffer polishing method is not intended to replace completely conventional means of polishing, but rather to supplement them and permit additional samples to be examined, without an excessive waste of time. This method should also prove useful in those laboratories, where the metallographic work is not handled by one person alone, who can specialize on it, but is handled by persons who have other duties, and therefore need a fast and easy method to prepare their specimens for micro-examination.

MATERIALS & METHODS MANUAL

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This is another in a series of Manuals on engineering materials and processing methods, published at periodic intervals as special sections in Materials & Methods. Each of them is intended to be a compressed handbook on its particular subject and to be packed with useful reference data on the characteristics of certain materials or metal forms or with essential principles, best procedures and operating data for performing specific metalworking processes.

Processing Equipment for Peacetime Production —a Review and Directory

by the Editors of Materials & Methods

War production saw the introduction and application of many new materials and processing methods. In our October 1945 issue we reviewed wartime progress in engineering materials, particularly developments in new materials and new uses of special interest to peacetime product planners. This review will serve the same purpose with respect to equipment for processing materials. It is intended (1) to review the highlights of development of new and extended application of existing equipment, and (2) to give a ready reference directory for the major types of processing equipment.

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Materials & Methods, June 1946
(Published Since 1929 as Metals and Alloys)

Introduction

During the past few years American industry, in order to save itself through the preservation of our country, established new records in speed and accuracy of production. However, this was done with little or no regard for cost. Now with the long pent-up demand for products of any type there is still an unabated demand for speed and accuracy of production. The difference is that because of skyrocketing material and labor costs economy has again become a dominant factor.

In spite of the cascades that poured from the plants of machine and equipment manufacturers, a majority of plant equipment now in use can be classed as obsolete. Similar cascades can continue for many more years before every plant equips itself to fight it out on an even basis with its competitors and to hold its own against economic pressures.

Many new types of equipment for processing and fabricating engineering materials have made their debut since 1941, and many processes that were in their swaddling clothes before that time have attained maturity under the stimulus of extreme urgency. It is our belief that we will see no more than a temporary lull in development of new equipment for better and more economical production. For instance, many manufacturers of machine tools were too busy developing special purpose machines and providing tooling for standard machines to transfer their new ideas from mind to drawing board. Now they are converting ideas to machines and before long we shall see more new marvels of equipment.

In the entire gamut of production—casting or forging, welding, machining, heat treating, finishing or inspection—methods are being studied from a new viewpoint. Many of the old prejudices against certain processes or types of equipment were overcome through enforced adoption to fulfill wartime contracts. Thus in setting-up production lines for peacetime production, many companies have made a clean break with the past. The cost element has become so important that how a process works means much less than for how little per piece it can turn out the required parts.

Melting and Casting

In order to obtain necessary production, foundries throughout the country adopted automatic equipment wherever possible and modernized their melting methods. Their products, in many cases, were improved through the adoption of high production inspection techniques such as X-ray, Magnafluxing and the use of target inspection fixtures for checking the dimensions of castings. Too, the widespread adoption of permanent mold castings resulted in more and better castings of certain types and served to introduce much new equipment into foundries.

Centrifugal castings reached a high state of perfection, although during the forward march of this process many applications were made out of desperation only to prove that centrifugal casting was supreme for some types of castings and should not be considered for others. Likewise vacuum casting introduced new methods and equipment into some foundries.

With the need for vast quantities of small parts which were rather complicated in design and which were of necessity light in weight, die castings came into use for parts which had to serve under adverse conditions. As the small parts proved themselves there came a demand for similar parts of increasing size. Now die casting equipment is available to produce die castings weighing as much as 35 lb.

In the casting field the one truly new method, as far as the production of anything but jewelry or dental parts is concerned, is precision casting by the "lost wax" method. This process, which might be said to have made possible production of huge quantities of super-charger buckets and turbine blades, has resulted in the development of some new types of equipment and the introduction of established equipment into new fields.

One newly introduced method promises to speed foundry output considerably. It is the use of dielectric heating to cure foundry cores which are prepared with plastic binders. This method (described in MATERIALS & METHODS, May 1946) is an excellent example of opening new applications for existing equipment.

Forging and Pressforming

Rather than being adversely affected by the introduction of many new methods of producing structural parts to be subjected to heavy service requirements there continued to be a heavy demand for forging equipment throughout the war. True, much of the newest forging equipment is of the press rather than the hammer type but the results are reasonably close and the products of both methods would amaze an old-time hammerman both as to size, finish and accuracy. Mechanical forging presses are now being made with capacities to equal steam hammers of 15,000-lb. capacity. Forging equipment is now much faster than that of several years ago and is capable of accuracies that will produce parts to accuracies of less than 0.002-in. tolerance without additional coining or sizing operations.

For pressing, drawing, stamping and other means of forming metal from sheets there has also been extensive changes in equipment. Not only have both mechanical and hydraulic presses increased in size but also in accuracy and in speed. For years mechanical presses have dominated the field of heavy drawings such as automobile bodies, but now hydraulic presses are being built in sizes sufficiently large to handle such work.

Some of the characteristics of hydraulic presses are used to advantage in special operations such as one case in which a press had an operating cycle of 3 hr. 20 min. During that period the press used varying pressures for extended periods for a finish forming operation, for a precision brazing operation and during cooling after spinning.

There was no great change in equipment used for brazing but rather an increased demand for this machinery; there was, however, some increase in size to permit production of some parts which reached diameters of 6-ft. Likewise, equipment was provided to handle the hot spinning of certain metals.

Rolling, Wire Drawing

In rolling metals, speeds and accuracies were increased enormously to meet the constantly increasing demand for metal sheet, strip and plate of all kinds. Most of the progress was made in cold reducing mills and thus were brought forth such mills as the Sendzimir, Uni-Temper and the 39-in. cluster type. Although differing in principle all were developed to achieve similar results, namely, greater reduction per pass, lower power cost, greater speed and greater accuracy. Rolling speeds of 5,000 to 6,000 f.p.m. became common, and it was not unusual to provide accuracy in cold strip in the nature of 0.0001 to 0.0003 in. Other advances that affected the rolling of metals and their mill finishing include sodium hydride descaling and electrolytic tin plating.

Improved die equipment permitted greater accuracy in wire drawing and enabled producers to draw wires in quantities to a diameter of 0.0001 in. or less. In an extreme case platinum wire was drawn to a fineness of 0.000017-in. dia. In all, improvements in machines and auxiliary equipment enabled the United States to become self-sufficient as far as fine wire was concerned.

Machines that permitted production of stepped extrusions helped to meet the need for odd-shaped parts with the elimination of several previously required operations. Sizes of ordinary types of extrusions were increased and the move was typified by the development of a press to produce nickel alloy pipe having an outside diameter of 9 in. with 1-in. wall thickness.

Similarly there was a great increase in the size of equipment, particularly presses, employed in the production of powder metal parts. For it is now possible and indeed practical to turn out powder metal bearings weighing as much as 228 lb. While not at the fully developed stage there has been enough experimentation to suggest that soon we will have equipment for the hot-pressing of powder metals, thus increasing physical characteristics of parts.

Machining

Since parts produced by all but a very few of the methods in general use require machining to some extent, it is natural that there was considerable improvement in and new applications for machine tools. First, there was the development of special machine tools to do one and only one job. These were stripped down to their essentials and through ingenious tooling were

able to do highly complicated operations with very little attention required from a semi-skilled operator. Next in importance would seem to be the use of unit type machines for multiple operations. Such machines took advantage of the availability of self-contained units for doing any one of many kinds of machining. These units were assembled into large automatic machines that would completely finish machine a part. One such machine had 28 separate stations to perform 31 distinct operations and attained a production rate of nearly 200 pieces per hour. Operations included drilling, reaming, boring, threading, milling and several allied steps.

Aircraft motor, radar equipment, gun pointers and other complex machines required a rapid multiplication of output of gears of all types and sizes. So it is not too surprising to find considerable improvement in machines designed for gear production. Among the most interesting developments in gear manufacture are machines that cut all teeth of a spur or helical gear at one time, and machines utilizing special cutters that complete the cutting of one gear tooth with each revolution of the cutter. Gear lappers also were found to be of importance in finishing of hardened gears on which grinding was considered inadvisable.

It has not been too long since it was discovered that carbide milling could be applied to steel as well as to cast iron. Consequently, milling machine manufacturers as well as manufacturers of boring mills and other equipment were required to provide more power and greater rigidity in their machines to make them capable of taking full advantage of the carbide tools. Some machines designed specifically for the use of carbide tools have already been placed on the market and others are certain to follow.

Likewise of interest in the field of machining are the changes in grinding. Some types of machines now use two or more wheels at the same time to grind odd shapes, doing jobs that formerly would have required two or more machines. Crushed wheel grinding helps to produce the enormous quantity of threaded parts required. For similar parts the thread rolling method has come into high favor and threads formed in this manner have found wide acceptance; in fact, they are preferred in many cases to hardened and ground threads.

Automatic operation has been extended to most types of machine tools either in the machine itself or by the addition of attachments. One of the latest such machines is a vertical turret lathe that can be steered automatically through 40 operations merely by putting the machine through its paces once by manual operation and then setting the controls at each stage of the operation. In another case a milling machine has been made to rise and fall to meet the surface of a stepped piece of metal. Lathes are now made to follow a flat master to cut a shaft having several diameters or tapers.

Broaching was once considered only for work that was comparatively crude but now is adaptable to really fine work. Indeed, improvement in machines and broaching tools permitted the rifling of fine guns by this method thereby helping to equip an army that started from scratch.

Heat Treating

Where difficult operating conditions and long-lived accuracy are conditions the part must meet, there is generally a need for heat treating, so it is only natural that heat treating equipment should come in for a large share of attention. This naturally resulted in improvement of old heat treating equipment and new methods of heating.

Most of the heat treating development was in the direction of methods and equipment that would overcome the age-old bogies of distortion, scaling and decarburization. Induction heating machines were so improved that they could be used for all types of parts except the very largest with the equipment turning out finish hardened pieces at high rates that kept pace with most production schedules.

Older and more established heating methods were also mechanized to keep apace with climbing production schedules. Flame hardening was made automatic for both heating and quenching; gas and electric furnaces were better designed to handle larger loads and to heat faster by such means as forced convection. Better and more accurate control was applied to the equipment to assure proper heat for the proper time, going far to eliminate guesswork from the heating process.

Much of the improvement in heat treating can be credited to the use of neutral, carburizing or decarburizing atmospheres in the furnaces. Use of carburizing atmospheres permitted the application of skin recovery operations to steel parts to permit pieces of thinner section being used to handle job formerly reserved for comparatively thick parts. Naturally these applications could not have been made without the availability of good atmosphere generators which came into being.

Introduced to either complete the heat treating of tool steels and alloy steels or to prevent the age hardening of aluminum alloy was the cold treatment method. For this we saw equipment taking its place in metalworking plants that was the same as that which had been used for quick freezing of food in the home. Such machines now available are vastly superior to those used in the early days and much more is known about the proper application of sub-zero temperatures. In the case of the alloy steels temperatures down to —130 F were used to complete the transformation of martensite immediately after quenching.

One of the newest methods in the field of heat treating is salt bath heating and quenching. Equipment developed for this purpose was quite different than that used for any other purpose and is being applied to many heat treating tasks difficult to complete successfully by other means.

In the opinion of many, the outstanding recent trend in heat treating equipment is the growing use of high-intensity gas flame heating using banks of easily controlled radiant ceramic burners. Heating may be unusually rapid and the process is applicable to both through heating and selective- or surface-heating.

Welding

Prior to the war welding was just becoming an important process, and in many plants where it was used welding was more in the nature of a salvaging or repair operation. Now that plant that does not rely upon welding of one type or other is a rarity.

The latest type of welding and one for which equipment will be available in the not-too-distant future is multiple arc welding in which both a.c. and d.c. current is used. It has proved successful in welding thin aluminum sheet, some of which was once considered unweldable.

In electric welding we have seen the widespread application of automatic arc welding equipment. There have been many examples of this type of welding increasing production manyfold on both large and small parts. Difficult-to-weld materials benefitted from the introduction of shielded arcs, protected by helium or argon, that prevented oxidation of the weld. Atomic hydrogen arc welding, too, aided in the solution of many delicate or specialized problems.

Because so many complex parts were broken down into simple components there was a need for many different types of resistance welding and led to the development of many new types of equipment. Among the types of welding machines introduced during the last five years are the capacitor discharge machines and storage battery welders. Both types of machines were developed to overcome current variations which prove harmful to this type of welding. Some special resistance welding machines were devised to make hundreds of welds almost instantaneously.

For some of the same reasons that resistance welding became extremely popular, namely the breaking down of complex parts into simple components, brazing attained a new stature. Very little new equipment was required to perfect brazing techniques. Rather it was the application of other types of equipment to this field. Brazing is being done on induction heating machines, in gas and electric furnaces and by means of salt baths or with gas flames. Some brazing is done alone, but in many cases brazing and heat treating are combined in one operation.

Naturally gas welding has moved along with the rest of the field and it is still as popular as ever. Too, equipment for this type of welding has been improved. One instance is in pressure welding for butt joints. Gas welding equipment is incorporated into machines which carefully regulate the heat and pressure necessary to make satisfactory butt joints.

Cleaning and Finishing

Cleaning and finishing processes have been given much more attention during the last few years. There has not been too much in basically new equipment, but like most other processing methods these have been converted to automatic operation. Previously there was considerable automatic equipment for large installations, but most was specially built. Lately there has become available automatic or semi-automatic equipment that could be used for plating or cleaning jobs without any special engineering.

Two of the brand new finishing methods are electrostatic spraying and detearing and electrolytic polishing. The latter is particu-

larly suited to polishing stainless steel and has been proved extremely valuable in cleaning small deep parts that would be hard to polish by any other method.

Shot blasting has long been regarded as a satisfactory cleaning process when using either metal shot, sand or other types of hard abrasive materials. However, it was recently learned that shot blasting when using certain types of steel grit could become shot peening and serve to increase the surface properties of certain metals. In the early days of shot blasting and peening most of the work was done by an operator directing a stream of the abrasive at the part through a hose and nozzle. When these methods became more popular special machines were designed to more accurately apply the materials. A related method of cleaning and finishing, using abrasive materials and chemical emulsions is known as vapor blasting.

It is generally conceded that our recently achieved production records could not have been attained were it not for the quality of testing and inspection equipment, and the ease with which such equipment was used by relatively inexperienced persons. Much of the testing and inspection equipment now considered as indigenous to the production floor less than five years ago was little known in any part of the factory except the laboratory. X-rays and surface roughness checking machines were once instruments just for the scientist but now can be used by most anyone.

Credit for better inspecting along production lines must be given the air and electronic gages developed during the last few years. Such inspecting machines (for many of them really should be classed as machines) eliminate the human element in determining whether or not a given product meets requirements. Too, especially in the electronic gages, measurements were amplified to provide ease in reading. When inexperienced help was first channeled into inspection jobs there was a great deal of awe in the minds of this type of help when confronted with tolerances of ten-thousandths of an inch. When such tiny dimensions were made to appear as large as a couple of inches on the scale the fears were dissipated.

Inspection equipment is now available to check several dimensions at one time. The machine which does the inspecting is almost human in its action. For instance, there was recently shown a machine for inspecting piston rings for automotive motors. This machine not only determines the suitability of the part for use but discards unfit parts according to the defect.

Latest in inspection methods is the use of supersonics to detect voids, fractures, and other faults in solid materials. There are two types of equipment available now. One type works on much the same principle as radar with sound waves bouncing back from the fault, if any. The other sends the supersonic waves through the material to a receiver on the other side. Change in speed of the waves locates the fault if there is one.

Conclusion

From the foregoing review of the high-spots in equipment developments of the past few years it can be seen that there are many changes in all phases of fabricating, processing and finishing the various engineering materials. Many variables enter into the purchase of equipment for any type of processing, but regardless of the conditions imposed by varying circumstances there seems to be equipment that can do completely satisfactory work in an economical manner.

Following this review appears a comprehensive directory of major types of equipment. As can be noted in a casual glance, this directory has been broken down into the major fields of interest of the readers of this magazine as far as processing methods are concerned. For instance, under the heading of melting and casting will be found the names of the manufacturers of all of the essential equipment used in melting and casting. Thus the reader will be saved the bother of going through the complete directory to locate the manufacturers of a few types of equipment in which he may be interested.

It is inevitable that a major undertaking of this sort in its first appearances will contain a few errors and omissions. We have done our best to keep such errors and omissions to a minimum and assure our readers that they will be even less in future issues of this and other directories that we shall publish.

Directory of Processing Equipment

This directory of machinery and equipment for the production, fabrication and treating of metals is designed to be of the utmost help to its users. Rather than listing all types of equipment in alphabetical order, regardless of the ultimate use, all types of machinery necessary to any given type of work is grouped under that main classification. For instance under the heading "Welding and Joining" will be found the manufacturers of the following types of equipment: arc welding, brazing, fastening and riveting, oxacetylene welding and resistance welding. Under each of these headings will be found the subdivisions covering that class of equipment.

The listing of tools, accessories and other auxiliary equipment has not been attempted in this directory. To give comprehensive coverage to that type of listing will require another directory comparable in size to this one. Such a directory will be published at a later date.

Casting

Centrifugal Casting Equipment

Allis Chalmers Mfg. Co., Milwaukee, Wis.
Centrifugal Casting Machine Co., Tulsa, Okla.
Kerr Dental Mfg. Co., Detroit
Wm. Loeffler Machine Co., Sheboygan, Mich.
Alexander Saunders & Co., New York
Tate-Jones & Co., Inc., Pittsburgh

Die Casting Equipment

A.C. Spark Plug Div. of G.M.C., Flint
Cleveland Automatic Machine Co., Cleveland
DCMT Sales Corp., New York
Dollin Corp., Irvington, N. J.
G. & N. Mfg. Co., Cleveland
H. L. Harvill Mfg. Co., Vernon, Cal.
Hydraulic Press Mfg. Co., Mt. Gilead, Ohio
Hydropress, Inc., New York
Kux Machine Co., Chicago
Lester-Phoenix, Inc., Cleveland
Madison-Kipp Corp., Madison, Wis.
Matthews & Co., Pittsburgh
Newton-New Haven Co., New Haven, Conn.
Reed-Prentice Corp., Worcester, Mass.

Melting Furnaces, electric arc

Ajax Electric Furnace Corp., Philadelphia 23
Ajax Electrothermic Corp., Trenton 5, N. J.
American Bridge Co., Pittsburgh
American Electric Furnace Co., Boston
Coloric Electric Corp., Hartford, Conn.
Detroit Electric Furnace Div, Kuhlman Electric Co., Bay City, Mich.
Greene Electric Furnace Co., Seattle, Wash.
James H. Knapp Co., Los Angeles
Pittsburgh Lectromelt Furnace Corp., Pittsburgh
R-S Products Corp., Philadelphia
C. Roffy Mfg., Los Angeles
Swindell-Dressler Corp., Pittsburgh 30
Whiting Corp., Harvey, Ill.
Edwin L. Wiegand, Pittsburgh

Melting Furnaces, electric, induction

Ajax Electric Furnace Corp., Philadelphia 23
Ajax Electrothermic Corp., Trenton, N. J.
Ajax Engineering Corp., Trenton, N. J.
Allis Chalmers Mfg. Co., Milwaukee, Wis.
Induction Heating Corp., New York
Kerr Dental Mfg. Co., Detroit
Lepel High Frequency Laboratories, New York 23
Pittsburgh Lectromelt Furnace Corp., Pittsburgh
R-S Products Corp., Philadelphia

Melting Furnaces, fuel fired

Acme Furnace Co., Chicago
American Gas Furnace Co., Elizabeth, N. J.
Amsler-Morton Co., Pittsburgh 22
Bellevue Industrial Furnace Co., Detroit
Blaw-Knox Div. of Blaw-Knox Co., Blawnox, Pa.
Campbell-Hausfeld Co., Harrison, Ohio
Chamberlain Co., Los Angeles
Continental Industrial Engineers Inc., Chicago
Dempsey Industrial Furnace Corp., Springfield, Mass.
Denver Fire Clay Co., Denver
Fisher Furnace Co., Chicago
Johnson Gas Appliance Co., Cedar Rapids, Iowa
Loftus Engineering Corp., Pittsburgh
Arthur G. McKee & Co., Cleveland 1
Morrison Engineering Corp., Cleveland
R-S Products Corp., Philadelphia
Reliable Gas Products Co., Cedar Rapids, Iowa
W. S. Rockwell Co., Fairfield, Conn.
Salem Engineering Co., Salem, Ohio
Selas Corp. of America, Philadelphia
Surface Combustion Corp., Toledo, Ohio
Swindell-Dressler Corp., Pittsburgh 30
Tate-Jones & Co., Inc., Pittsburgh
U. S. Smelting Furnace Co., Belleville, Ill.
Wellman Engineering Co., Cleveland

Precision Casting Equipment

American Cyanamid Co., New York
Carbide & Carbon Chemicals Co., New York
Cerro de Pasco Copper Corp., New York
Gehnrich Oven Div., W. S. Rockwell Co., Fairfield, Conn.
General Electric Co., Pittsfield, Mass.
Glyco Products Co., Brooklyn
Jelrus Co., New York
Kerr Dental Mfg. Co., Detroit
Alexander Saunders & Co., New York
Titanium Alloy Mfg. Co., Niagara Falls, N. Y.
Whipmix Corp., Louisville, Ky.
J. Yates Dental Mfg. Co., Chicago

Metal Forming

Forging and Forming

Drop Forging Hammers

Alliance Machine Co., Alliance, Ohio
Billings & Spencer Co., Hartford, Conn.
Chambersburg Engineering Co., Chambersburg, Pa.
Eagle Iron Works, Des Moines, Iowa
Engel Aircraft Specialties, Escondido, Cal.
Erie Foundry Co., Erie, Pa.
Industrial Brownhoist Corp., Bay City, Mich.
Morgan Engineering Co., Alliance, Ohio
Pneumatic Drop Hammer Co., Braintree, Mass.
San Francisco Engineering Co., San Francisco, Cal.
Toledo Machine & Tool Div., Toledo, Ohio
Western Iron & Foundry Co., Wichita, Kansas
Williams, White & Co., Moline, Ill.

Forging Machines, hot and cold heading

Ajax Mfg. Co., Cleveland
Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.
E. W. Bliss Co., Brooklyn
Erie Foundry Co., Erie, Pa.
Hill Acme Co., Cleveland
Morgan Engineering Co., Alliance, Ohio
National Machinery Co., Tiffin, Ohio
Pawtucket Manufacturing Co., Pawtucket, R. I.
Toledo Machine & Tool Co., Toledo, Ohio
Waterbury Farrel Fdry. & Machine Co., Waterbury, Conn.

Furnaces, reheating and forging (see under Heat Treating and Heating)

Presses, blanking, coining, embossing, piercing, punching

Acromark Co., Elizabeth, N. J.
Ajax Mfg. Co., Cleveland
Altair Machinery Corp., New York
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia 42
Beatty Machine & Mfg. Co., Hammond, Ind.
Benchmaster Mfg. Co., Los Angeles
Bertsch & Co., Cambridge City, Ind.
E. W. Bliss Co., Brooklyn
Bollaert Punch Co., Oakland, Cal.
Brandtjen & Kluge Inc., St. Paul, Minn.
Buffalo Forge Co., Buffalo, N. Y.
Callahan Can Machine Co., Inc., Brooklyn
Chambersburg Engineering Co., Chambersburg, Pa.
Cincinnati Shaper Co., Cincinnati
Clearing Machine Corp., Chicago
Cleveland Crane & Engineering Co., Wickliffe, Ohio
Cleveland Punch & Shear Works Co., Cleveland
A. W. Clough, Meridan, Conn.
Consolidated Machine Tool Corp., Rochester 10, N. Y.
Continental Foundry & Machine Co., E. Chicago, Ind.
Denison Engineering Co., Columbus
Diamond Machine Co. of Phila., Philadelphia
Di-Machine Corp., Chicago
Elmes Engineering Wks. of American Steel Foundries, Chicago
Embosograf Corp. of America, New York
Epworth Mfg. Co., Detroit
Erie Foundry Co., Erie, Pa.
Excelsior Tool & Machine Co., East St. Louis, Ill.
Famco Machine Co., Racine, Wis.
A. B. Farquhar Co., York, Pa.
Farrel-Birmingham Co., Inc., Ansonia, Conn.
Federal Press Co., Elkhart, Ind.
Ferracute Machine Co., Bridgeton, N. J.
Flexo Machines Co., Chicago
French Oil Mill Machy. Co., Piqua, Ohio
Hannifin Mfg. Co., Chicago
Havier Mfg. Co., St. Paul, Minn.
Hendley & Wittemore Co., Beloit, Wis.
Henry & Wright Mfg. Co., Hartford, Conn.
Hydraulic Machinery Inc., Dearborn, Mich.
Hydraulic Press Mfg. Co., Mt. Gilead, Ohio
O. C. Keckley Co., Springfield, Ill.
Kux Machine Co., Chicago
L & J Press Corp., Elkhart, Ind.
Lake Erie Engineering Corp., Buffalo, N. Y.
Evarts G. Loomis Co., Newark, N. J.
Marshalltown Mfg. Co., Marshalltown, Iowa
Jas. H. Matthews Co., Pittsburgh
Max Ams Machine Co., Bridgeport, Conn.
Milliken Machine Co., West Newton, Mass.
Minster Machine Co., Minster, Ohio
Morgan Engineering Co., Alliance, Ohio
Multiple Boring Machine Co., St. Louis, Mo.
National Machinery Co., Tiffin, Ohio
New Albany Machine Mfg. Co., New Albany, Ind.
Niagara Machine & Tool Works, Buffalo, N. Y.
Noble & Westbrook Mfg. Co., East Hartford, Conn.
Oilgear Co., Milwaukee, Wis.
Olsenmark Corp., New York
Pannier Bros. Stamp Co., Pittsburgh
Peck, Stow & Wilcox Co., Southington, Conn.
Perkins Machine Co., Warren, Mass.
Pneumatic Drop Hammer Co., Braintree, Mass.
Potdevin Machine Co., Brooklyn
Rockford Iron Works, Chicago
David J. Ross Co., Inc., Benton Harbor, Mich.
Sales Service Machine Tool Co., St. Paul, Minn.
Seybold Div. of Harris-Seybold-Potter Co., Dayton, Ohio
Sheridan Iron Works, Champlain, N. Y.
Standard Machinery Co., Providence, R. I.
Studebaker Machine Co., Maywood, Ill.
F. J. Swaine Co., St. Louis, Mo.
Thomas Machine Mfg. Co., Pittsburgh
Thomson-National Press Co., Franklin, Mass.
Toledo Machine & Tool Co., Toledo, Ohio
Union Tool Co., Rochester, N. Y.
United Engineering & Fdry. Co., Pittsburgh 22
U. S. Tool Co., Inc., East Orange, N. J.
V & O Press Co. Inc., Hudson, N. Y.
Verdin, Kappes & Verdin Co., Cincinnati
Verson Allsteel Press Co., Chicago
Wales Strippit Corp., Tonawanda, N. Y.
Walsh Press & Die Co., Chicago
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
Watson-Stillman Co., Roselle, N. J.
Wean Engineering Co. Inc., Warren, Ohio
Frank L. Wells Co., Kenosha, Wis.
Whitney Metal Tool Company, Rockford, Ill.
Wiedemann Machine Co., Philadelphia
Williams White & Co., Moline, Ill.
R. D. Wood Co., Philadelphia
Zeh & Hahnemann Co., Newark 5

Presses, extrusion

Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia 42
Beatty Machine & Mfg. Co., Hammond, Ind.
E. W. Bliss Co., Brooklyn
Clearing Machine Corp., Chicago
Denison Engineering Co., Columbus
Elmes Engineering Wks., Chicago
Epworth Mfg., Detroit
Erie Foundry Co., Erie, Pa.
Farrel-Birmingham Co., Inc., Ansonia, Conn.
Henry & Wright Mfg. Co., Hartford, Conn.
Hydraulic Press Mfg. Co., Mt. Gilead, Ohio
Hydropress, Inc., New York
Lake Erie Engineering Corp., Buffalo, N. Y.
Mesta Machine Co., Pittsburgh 30
Oilgear Co., Milwaukee, Wis.
Schloemann Engineering Corp., Pittsburgh 22
Studebaker Machine Co., Maywood, Ill.
Toledo Machine & Tool Co., Toledo, Ohio
Verson Allsteel Press Co., Chicago
Watson-Stillman Co., Roselle, N. J.
R. D. Wood Co., Philadelphia

Presses, forging

Adamson Machine Co., Akron, Ohio
Ajax Mfg. Co., Cleveland
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia 42
Beatty Machine & Mfg. Co., Hammond, Ind.
Birdsboro Steel Frdy. & Machine Co., Birdsboro, Pa.
E. W. Bliss Co., Brooklyn
Chambersburg Engineering Co., Chambersburg, Pa.
Clearing Machine Corp., Chicago
Cleveland Punch & Shear Works Co., Cleveland
Denison Engineering Co., Columbus
Elmes Engineering Wks., Chicago
Emerman Machinery Corp., Chicago
Epworth Mfg. Co., Detroit
Erie Foundry Co., Erie, Pa.
A. B. Farquhar Co., York, Pa.
Ferracute Machine Co., Bridgeton, N. J.
Henry & Wright Mfg. Co., Hartford, Conn.
Hydraulic Press Mfg. Co., Mount Gilead, Ohio
Hydropress Inc., New York 22
Lake Erie Engineering Corp., Buffalo, N. Y.
Loewy Engineering Co., Ltd., New York
Mesta Machine Co., Pittsburgh 30
Minster Machine Co., Minster, Ohio
Morgan Engineering Company, Alliance, Ohio
National Machinery Co., Tiffin, Ohio
Niagara Machine & Tool Wks., Buffalo, N. Y.
Schloemann Engineering Corp., Pittsburgh 22
Standard Machinery Co., Providence, R. I.
Toledo Machine & Tool Co., Toledo, Ohio
United Engineering & Foundry Co., Pittsburgh
Verson Allsteel Press Co., Chicago
Watson-Stillman Co., Roselle, N. J.
Williams, White & Co., Moline, Ill.

R. D. Wood Co., Philadelphia

Presses, screw

E. W. Bliss Co., Brooklyn
General Mfg. Co., Detroit
McWilliams Mfg. Co., Inc., Providence, R. I.
Standard Machinery Co., Providence, R. I.
Toledo Machine & Tool Co., Toledo, Ohio
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
Whitney Metal Tool Company, Rockford, Ill.

Presses and Machines, bending, straightening, stretching

Aetna-Standard Engineering Co., Youngstown 1, Ohio
Air Hydraulics Div., Beyer Machine Co., Jackson, Mich.
Alliance Machine Co., Alliance, Ohio
American Broach & Machine Co., Ann Arbor, Mich.
American Foundry Equipment Co., Mishawaka, Ind.
American Pipe Bending Machine, Poultney, Vt.
Anderson Bros. Mfg. Co., Rockford, Ill.
Arcade Mfg. Co., Freeport, Ill.
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia 42
John S. Barnes Corp., Rockford, Ill.
Barth Mfg. Co., Milldale, Conn.
Beatty Machine & Mfg. Co., Hammond, Ind .
Bertsch & Co., Cambridge City, Ind.
Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.
E. W. Bliss Co., Brooklyn
Buffalo Forge Co., Buffalo, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Cincinnati Shaper Co., Cincinnati
Cleveland Crane & Engineering Co., Steelweld Machinery Div., Wickliffe, Ohio
Cleveland Punch & Shear Works Co., Cleveland
Consolidated Machine Tool Corp., Rochester 10, N. Y.
Cyril Bath Co., Cleveland
Denison Engineering Co., Columbus
Epworth Mfg. Co., Detroit
Erie Foundry Co., Erie, Pa.
Farnham Mfg. Co., Buffalo, N. Y.
A. B. Farquhar Co., York, Pa.
Ferracute Machine Co., Bridgeton, N. J.
General Mfg. Co., Detroit
David Gessner Co., Worcester, Mass.
Hannifin Mfg. Co., Chicago 24
Hydraulic Machinery, Inc., Dearborn, Mich.
Hydraulic Press Mfg. Co., Mt. Gilead, Ohio
Hydropress, Inc., New York 22
Indianapolis Machinery & Supply Co., Inc., Indianapolis, Ind.
Irwin O'Neill Mfg. Co., Minneapolis 15, Minn.
Kane & Roach, Inc., Syracuse, N. Y.
Kardong Bros., Inc., Minneapolis 13, Minn.
O. C. Keckley Co., Springfield, Ill.
Lake Erie Engineering Corp., Buffalo, N. Y.
Lewis Foundry & Machine Div. of Blaw-Knox Co., Pittsburgh 30
Lewis Machine Co., Cleveland 4
Lewthwaite, T. H., Machine Co., Inc., New York 17
Littell, F. J., Machine Co., Chicago 13
Loewy Eng'g. Co. Ltd., New York
Logemann Brothers Co., Milwaukee 10, Wis.
Loma Machine Mfg. Co., Inc., New York
McWilliams Mfg. Co., Inc., Providence, R. I.
Medart Co., St. Louis 18, Mo.
Mesta Machine Co., Pittsburgh 30
Morgan Construction Co., Worcester, Mass.
Morgan Engineering Co., Alliance, Ohio
Naudain Mfg. Co., Baltimore
Niagara Machine & Tool Works, Buffalo 11, N. Y.
Oilgear Co., Milwaukee, Wis.
O'Neil-Irwin Mfg. Co., Minneapolis, Minn.
Peck, Stow & Wilcox Co., Southington, Conn.
Pedrick Tool & Machine Co., Philadelphia
Pines Engineering Co., Aurora, Ill.
Potter-Rayfield, Atlanta, Ga.
Rolled Thread Die Co., Worcester, Mass.
T. W. & C. B. Sheridan Co., New York
Sheridan Iron Wks., Champlain, N. Y.
Standard Machinery Co., Providence, R. I.
Streine Tool & Mfg. Co., New Bremen, Ohio
Studebaker Machine Co., Maywood, Ill.
Taylor-Wilson Manufacturing, Pittsburgh
Thomas Machine Mfg. Co., Pittsburgh
Toledo Machine & Tool Co., Toledo, Ohio
United Engineering & Foundry Co., Pittsburgh
Verson Allsteel Press Co., Chicago
Wallace Supplies Mfg. Co., Chicago
Watson-Stillman Co., Roselle, N. J.
Wean Engineering Co., Inc., Warren, Ohio
Webb Corp., Webb City, Mo.
Williams White & Co., Moline, Ill.
Whitney Metal Tool Company, Rockford, Ill.
R. D. Wood Co., Philadelphia
Yoder Co., Cleveland 2
Youngstown Foundry & Machine Co., Youngstown, Ohio
Zeh & Hahnemann Co., Newark 5

Presses and Machines, drawing, stamping

Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia 42
Beatty Machine & Mfg. Co., Hammond, Ind.
Benchmaster Mfg. Co., Los Angeles
Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.
E. W. Bliss Co., Brooklyn
Callahan Can Machine Co., Brooklyn
Cameron Can Machinery Co., Chicago
Chambersburg Engineering Co., Chambersburg, Pa.
Cincinnati Shaper Co., Cincinnati
Clearing Machine Corp., Chicago
Cleveland Punch & Shear Co., Cleveland
Denison Engineering Co., Columbus
Di-Machine Corp., Chicago
Dorr-Patterson Engineering Co., Detroit
Elmes Engineering Wks., Chicago
Epworth Mfg. Co., Detroit
A. B. Farquhar Co., York, Pa.
Ferracute Machine Co., Bridgeton, N. J.
Hannifin Mfg. Co., Chicago
Henry & Wright Mfg. Co., Hartford, Conn.
Hydraulic Machinery, Inc., Dearborn, Mich.
Hydraulic Press Mfg. Co., Mt. Gilead, Ohio
Hydropress, Inc., New York
Interstate Machinery Co., Inc., Chicago
Johnson Machine & Press Corp., Elkhart, Ind.
Klaas Machine & Mfg. Co., Cleveland
L. & J. Press Corp., Elkhart, Ind.
Lake Erie Engineering Corp., Buffalo, N. Y.
Loewy Engineering Co., New York
H. Jas. Matthews & Co., Pittsburgh 13
Max Ams Machine Co., Bridgeport, Conn.
Maxant Button & Supply Co., Chicago
Minster Machine Co., Minster, Ohio
New Albany Machine Mfg. Co., New Albany, Ind.
Niagara Machine & Tool Works, Buffalo 11, N. Y.
Niagara Machine & Tool Works, Buffalo, N. Y.
George A. Ohl & Co., Newark
Peck, Stow & Wilcox Co., Southington, Conn.
Perkins Machine Co., Warren, Mass.
Progressive Welder Co., Detroit 12
Rockford Iron Works, Chicago
Scholeman Engineering Corp., Pittsburgh
Service Machine Co., Chicago
Standard Machinery Co., Providence, R. I.
Studebaker Machine Co., Maywood, Ill.
Thomas Machine Mfg. Co., Pittsburgh
Toledo Machine & Tool Co., Toledo, Ohio
U. S. Tool Co., Inc., East Orange, N. J.
V & O Press Co., Inc., Hudson, N. Y.
Verdin, Kappes & Verdin Co., Cincinnati
Verson Allsteel Press Co., Chicago
Walsh Press & Die Co., Chicago
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
Watson-Stillman Co., Roselle, N. J.
Williams White & Co., Moline, Ill.
Whitney Metal Tool Co., Rockford, Ill.
Wiedemann Machine Co., Philadelphia
R. D. Wood Co., Philadelphia
Zeh & Hahnemann Co., Newark 5

Rolls, bending and straightening

Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia 42
Bertsch & Co., Cambridge City, Ind.
E. W. Bliss Co., Brooklyn
Buffalo Forge Co., Buffalo, N. Y.
Camden Forge Co., Camden, N. J.
Cleveland Punch & Shear Works Co., Cleveland 14
Consolidated Machine Tool Corp., Rochester, N. Y.
Erie Forge Co., Erie, Pa.
Farnham Mfg. Co., Buffalo, N. Y.
A. Finkl & Son Co., Chicago
Hannifin Mfg. Co., Chicago 24
Hendley & Whittemore Co., Beloit, Wis.
Hilyard Co., Norristown, Pa.
Kane & Roach, Inc., Syracuse, N. Y.
Kling Bros. Engineering Works, Chicago
Mackintosh-Hemphill Co., Pittsburgh
Maplewood Machinery Co., Chicago
Medart Co., St. Louis 18, Mo.
Niagara Machine & Tool Works, Buffalo, N. Y.
Geo. A. Ohl & Co., Newark
Pennsylvania Forge Corp., Philadelphia
Jos. T. Ryerson & Son, Inc., Chicago
Struthers-Wells Corp., Titusville, Pa.
Tishken Products, Detroit
United States Steel Supply Co., Chicago
Wean Engineering Co. Inc., Warren, Ohio
Webb Corp., Webb City, Mo.
George Whiting Co., Chicago
Williams, White & Co., Moline, Ill.

Rolls, forging and tapering

Ajax Mfg. Co., Cleveland
Camden Forge Co., Camden, N. J.
Erie Forge Co., Erie, Pa.
Kennedy-Van Saun Mfg. & Engineering Co., Danville, Pa.
Franklin S. Miles, Philadelphia
National Forge & Ordnance Co., Warren County, Pa.
Taylor-Wilson Mfg., Pittsburgh
Williams White & Co., Moline, Ill.

Spinning Equipment

E. W. Bliss Co., Brooklyn
Ferracute Machine Co., Bridgeton, N. J.
Toledo Machine & Tool Co., Toledo, Ohio.
Youngstown Foundry & Machine Co., Youngstown, Ohio

Swaging Machines

E. W. Bliss Co., Brooklyn
Breeze Corp., Inc., Newark
Andrew C. Campbell Div., Bridgeport, Conn.
Frederick M. Conran Machine Co., Newark
Etna Machine Co., Toledo, Ohio
Ferracute Machine Co., E. Bridgeport, Conn.
James R. Kearney Corp., St. Louis, Mo.
Langelier Mfg. Co., Providence, R. I.
Oilgear Co., Milwaukee, Wis.
Peck, Stow & Wilcox Co., Southington, Conn.
Sleeper & Hartley Inc., Worcester, Mass.
Standard Machinery Co., Providence, R. I.
Studebaker Machine Co., Maywood, Ill.
Toledo Machine & Tool Co., Toledo, Ohio
Torrington Co., Torrington, Conn.
V & O Press Co., Inc., Hudson, N. Y.
Vaill Engineering Co., Waterbury, Conn.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.

Thread Rolling and Knurling Equipment

E. W. Bliss Co., Brooklyn
Cameron Can Machinery Co., Chicago
E. O. Grabo Machine Works, New York
E. J. Manville Machine Co., Inc., Tiffin, Ohio
Max Ams Machine Co., Bridgeport, Conn.
National Electric Welding Machines Co., Bay City, Mich.
National Machinery Co., Tiffin, Ohio
Toledo Machine & Tool Co., Toledo, Ohio
H. P. Townsend Mfg. Co., Hartford, Conn.
V & O Press Co., Inc., Hudson, N. Y.
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
Watson-Flagg Machine Co., Paterson, N. J.

Powder Metallurgy Processing

Blending, Mixing and Classifying Machines

Abbe Engineering Co., New York
Baker Perkins, Inc., Saginaw, Mich.
Franklin-McAllister Corp., Chicago
Hardinge Co., York, Pa.
Lancaster Iron Works, Lancaster, Pa.
National Engineering Co., Chicago
Patterson Foundry & Machine Co., E. Liverpool, Ohio
H. K. Porter Co., Pittsburgh

Pulverizing Machinery Co., Summit, N. J.
Read Machinery Co., Inc., York, Pa.
Sturtevant Mill Co., Boston

Milling, pulverizing, and disintegrating equipment

Abbe Engineering Co., New York
Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.
American Pulverizer Co., St. Louis 10, Mo.
Babcock & Wilcox Co., New York 6
Franklin-McAllister Corp., Chicago
Hardinge Co., Inc., York, Pa.
Jeffrey Mfg. Co., Columbus
Patterson Foundry & Machine Co., E. Liverpool, Ohio
H. K. Porter Co., Pittsburgh
Pulverizing Machinery Co., Summit, N. J.
Raymond Pulverizer Div., Chicago
Stedman's Foundry & Machine Works, Aurora, Ind.
Sturtevant Mill Co., Boston
Vulcan Iron Works, Wilkes-Barre, Pa.

Powder Metal Presses

Baldwin-Southwark Div., Baldwin Locomotive Wks., Philadelphia
Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.
E. W. Bliss Co., Brooklyn
Fred S. Carver Co., New York
Clearing Machine Co., Chicago
Arthur Colton Co., Detroit
Continental Machines Inc., Minneapolis, Minn.
Defiance Machine Works, Inc., Defiance, Ohio
Denison Engineering Co., Columbus
Chas F. Elmes Eng'g. Works, Chicago
A. B. Farquhar Co., Ltd., York, Pa.
Hydraulic Machinery Inc., Dearborn, Mich.
Hydraulic Press Mfg. Co., Mt. Gilead, Ohio
Hydropress Inc., New York
Kux Machine Co., Chicago
Lake Erie Engineering Corp., Buffalo, N. Y.
Schloemann Engineering Corp., Pittsburgh
F. J. Stokes Machine Co., Philadelphia
Studebaker Machine Co., Maywood, Ill.
Taylor-Wilson Mfg., Pittsburgh
Toledo Machine & Tool Co., Toledo, Ohio
Watson-Stillman Co., Roselle, N. J.
Williams White & Co., Moline, Ill.
R. D. Wood Co., Philadelphia
Zeh & Hahnemann Co., Newark 5

Sintering Furnaces (see Heat Treating and Heating for specific types)

Rolling

Mills, bar

Aetna-Standard Engineering Co., Youngstown, Ohio
Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.
E. W. Bliss Co., Brooklyn
Continental Foundry & Machine Co., East Chicago, Ind.
Jackson & Church Co., Saginaw, Mich.
Kane & Roach, Inc., Syracuse, N. Y.
Lewis Foundry & Machine Div. of Blaw Knox Co., Pittsburgh
Mackintosh & Hamphill Co., Pittsburgh
Mesta Machine Co., Pittsburgh
Morgan Construction Co., Worcester, Mass.
Morgan Engineering Company, Alliance, Ohio
Treadwell Engineering Co., Easton, Pa.
United Engineering & Foundry Co., Pittsburgh
Youngstown Foundry & Machine Co., Youngstown, Ohio

Mills, billet and blooming

Aetna Standard Engineering Co., Youngstown, Ohio
Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.
E. W. Bliss Co., Brooklyn
Continental Foundry & Machine Co., East Chicago, Ind.
Hydropress, Inc., New York
Lewis Foundry & Machine Div. of Blaw-Knox Co., Pittsburgh
Mackintosh-Hemphill Co., Pittsburgh
Mesta Machine Co., Pittsburgh
Morgan Construction Co., Worcester, Mass.
Morgan Engineering Co., Alliance, Ohio
National Roll & Foundry Co., Avonmore, Pa.
Treadwell Engineering Co., Easton, Pa.
United Engineering & Foundry Co., Pittsburgh

Mills, cold and hot rolling

Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Baltimore Tube Co., Baltimore
Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.
E. W. Bliss Co., Brooklyn
Broden Construction Co., Cleveland
Cold Metal Process Co., Youngstown, Ohio
Continental Foundry & Machine Co., East Chicago, Ind.
Etna Machine Co., Toledo, Ohio
Farrel-Birmingham Co., Inc., Ansonia, Conn.
Hydropress, Inc., New York
Kane & Roach, Inc., Syracuse, N. Y.
Lewis Foundry & Machine Div. of Blaw Knox Co., Pittsburgh
Loewy Engineering Co., Ltd., New York
Mackintosh-Hemphill Co., Pittsburgh
McKay Machine Co., Youngstown, Ohio
McKinney Tool & Mfg. Co., Syracuse, N. Y.
McWilliams Mfg. Co., Inc., Providence, R. I.
Mesta Machine Co., Pittsburgh
Morgan Construction Co., Worcester, Mass.
Penna Engineering Wks., New Castle, Pa.
Schloemann Engineering Corp., Pittsburgh
Standard Machinery Co., Providence, R. I.
Toledo Machine & Tool Co., Toledo, Ohio
Treadwell Engineering Co., Easton, Pa.
United Engineering & Foundry Co., Pittsburgh
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
Wean Engineering Co., Warren, Ohio
Yoder Co., Syracuse, N. Y.

Mills, cold strip

E. W. Bliss Co., Brooklyn
Broden Construction Co., Cleveland
Cold Metal Process Co., Youngstown, Ohio
Continental Foundry & Machine Co., East Chicago, Ind.
Farrel-Birmingham Co., Inc., Ansonia, Conn.
Mackintosh & Hamphill Co., Pittsburgh
McWilliams Mfg. Co., Inc., Providence, R. I.
Mesta Machine Co., Pittsburgh
Morgan Construction Co., Worcester, Mass.
Standard Machinery Co., Providence, R. I.
Toledo Machine & Tool Co., Toledo, Ohio
Treadwell Engineering Co., Easton, Pa.
United Engineering & Foundry Co., Pittsburgh

Mills, hot strip

E. W. Bliss Co., Brooklyn
Cold Metal Products Co., Youngstown, Ohio
Continental Foundry & Machine Co., East Chicago, Ind.
Mesta Machine Co., Pittsburgh
Morgan Construction Co., Worcester, Mass.
Standard Machinery Co., Providence, R. I.
Toledo Machine & Tool Co., Toledo, Ohio
United Engineering & Foundry Co., Pittsburgh

Mills, plate

Aetna Standard Engineering Co., Youngstown, Ohio
Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.
E. W. Bliss Co., Brooklyn
Cold Metal Products Co., Youngstown, Ohio
Continental Foundry & Machine Co., East Chicago, Ind.
Hydropress, Inc., New York
Kane & Roack, Inc., Syracuse, N. Y.
Lewis Foundry & Machine Div. of Blaw-Knox Co., Pittsburgh
Mackintosh-Hemphill Co., Pittsburgh
Mesta Machine Co., Pittsburgh
Morgan Engineering Co., Alliance, Ohio
National Roll & Foundry Co., Avonmore, Pa.
Schloemann Engineering Corp., Pittsburgh
Toledo Machine & Tool Co., Toledo, Ohio
Treadwell Engineering Co., Easton, Pa.
United Engineering & Foundry Co., Pittsburgh
Youngstown Foundry & Machine Co., Youngstown, Ohio

Mills, rod, pipe and tube

Abbe Engineering Co., New York
Aetna-Standard Engineering Co., Youngstown 1, Ohio
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Electric Fusion Corp., Chicago
E. W. Bliss Co., Brooklyn
Colorado Iron Works Co., Denver
Continental Foundry & Machine Co., East Chicago, Ind.
Hardinge Co., Inc., York, Pa.
Hydropress, Inc., New York
International Engineering Inc., Dayton, Ohio
Kane & Roach, Inc., Syracuse, N. Y.
Kennedy-Van Saun Mfg. & Engineering Corp., Danville, Pa.
Loewy Engineering Co., Ltd., New York
Mackintosh-Hemphill Co., Pittsburgh 3
Maplewood Machinery Co., Chicago
McKay Machine Co., Youngstown, Ohio
Medart Co., St. Louis 18
Mesta Machine Co., Pittsburgh
Morgan Construction Co., Worcester, Mass.
Morse Bros. Machinery Co., Denver
Pines Engineering Co., Inc., Los Angeles
H. K. Porter Co., Inc., Pittsburgh
H. J. Ruesch Machine Co., Newark
Salem Engineering Co., Salem, Ohio
Schloemann Engineering Corp., Pittsburgh
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Tomkins Mining Machinery Corp., New York
Torrington Mfg. Co., Torrington, Conn.
Traylor Engineering & Mfg. Co., Allentown, Pa.
United Engineering & Fdry. Co., Pittsburgh 22
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
Wean Engineering Co. Inc., Warren, Ohio
Webber Equipment Co., New York
Yoder Company, Cleveland 2
Youngstown Foundry & Machine Co., Youngstown, Ohio

Mills, sheet

Aetna-Standard Engineering Co., Youngstown, Ohio
Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.
E. W. Bliss Co., Brooklyn
Broden Construction Co., Cleveland
Cold Metal Process Co., Youngstown, Ohio
Continental Foundry & Machine Co., East Chicago, Ind.
Hydropress, Inc., New York
Kane & Roach, Inc., Syracuse, N. Y.
Lewis Foundry & Machine Div. of Blaw Knox Co., Pittsburgh
Mesta Machine Co., Pittsburgh
Morgan Construction Co., Worcester, Mass.
National Roll & Foundry Co., Avonmore, Pa.
Toledo Machine & Tool Co., Toledo, Ohio
Torrington Mfg. Co., Torrington, Conn.
United Engineering & Foundry Co., Pittsburgh
Youngstown Foundry & Machine Co., Youngstown, Ohio

Mills, slabbing

Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.
E. W. Bliss Co., Brooklyn
Lewis Foundry & Machine Div. of Blaw-Knox Co., Pittsburgh
Mackintosh-Hemphill Co., Pittsburgh
Mesta Machine Co., Pittsburgh
Morgan Engineering Co., Alliance, Ohio
Standard Machinery Co., Providence, R. I.
United Engineering & Foundry Co., Pittsburgh

Wire Drawing and Forming

Wire Drawing Equipment

Aetna-Standard Engineering Co., Youngstown 1, Ohio
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
E. W. Bliss Co., Brooklyn
Broden Construction Co., Cleveland
Crucible Steel Co. of America, New York 17
Farrel-Birmingham Co. Inc., Ansonia, Conn.

Fidelity Machine Co., Philadelphia 24
Humphrey & Sons, Joliet, Ill.
Lewis Foundry & Machine Div. of Blaw-Knox Co., Pittsburgh 30
Lewis Machine Co., Cleveland 4
McKay Machine Co., Youngstown 2, Ohio
McWilliams Mfg. Co., Inc., Providence, R. I.
Morgan Construction Co., Worcester, Mass.
F. B. Shuster Mfg. Co., New Haven 9, Conn.
Sleeper & Hartley, Inc., Worcester, Mass.
Wm. E. Somerville & Co., Coal City, Ill.
Standard Machinery Co., Providence, R. I.
Superior Tool & Mfg. Co., Inc., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, Ohio
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
Wire Machinery Corp. of America, Inc., New Haven, Conn.

Wire Forming Equipment

E. W. Bliss Co., Brooklyn
Broden Construction Co., Cleveland
Kane & Roach, Inc., Syracuse, N. Y.
A. H. Nilson Machine Co., Bridgeport 5, Conn.
O'Neil-Irwin Mfg. Co., Minneapolis, Minn.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Machinery Co., Providence, R. I.
Toledo Machine & Tool Co., Toledo, Ohio
Torrington Manufacturing Co., Torrington, Conn.
U. S. Tool Co., Inc., East Orange, N. J.
Wean Engineering Co. Inc., Warren, Ohio
Frank L. Wells Co., Kenosha, Wis.

Machining

Boring

Boring Mills

Baush Machine Tool Co., Sringfield, Mass.
Bullard Co., Bridgeport, Conn.
Cincinnati Gilbert Machine Tool Co., Cincinnati
Cincinnati Planer Co., Cincinnati
Cleereman Machine Tool Co., Green Bay, Wis.
Consolidated Machine Tool Corp., Rochester 10, N. Y.
Covel Mfg. Co., Benton Harbor, Mich..
Cross Co., Detroit
Defiance Machine Works, Inc., Defiance, Ohio
DeVlieg Machine Co., Ferndale, Mich.
Ex-Cell-O Corp., Detroit
Fosdick Machine Tool Co., Cincinnati
General Machinery Corp., Hamilton, Ohio
Giddings & Lewis Machine Tool Co., Fond Du Lac, Wis.
G. A. Gray Co., Cincinnati
General Engineering & Mfg. Co., St. Louis
Heald Machine Co., Worcester 6, Mass.
Jones Machine Tool Wks., Inc., Philadelphia
Kearney & Trecker Corp., Milwaukee, Wis.
Lemaire Tool & Mfg. Co., Dearborn, Mich.
W. K. Millholland Machinery Co., Indianapolis, Ind.
Moline Tool Company, Moline, Ill.
National Automatic Tool Company, Inc., Richmond, Ind.
O'Brien Machinery Co., Philadelphia
Portage Machine Co., Akron, Ohio
Rogers Machine Wks., Inc., Buffalo, N. Y.
Sellers, William, & Co., Inc., Philadelphia 30

Jig Borers

Baker Bros., Inc., Toledo, Ohio
Bryant Machinery & Eng. Co., Chicago 6
Cincinnati Bickford Tool Co., Cincinnati
Cleereman Machine Tool Co., Green Bay, Wis.
DeVlieg Machine Co., Ferndale, Mich.
Fosdick Machine Tool Co., Cincinnati
Giddings & Lewis Machine Tool Co., Fond du Lac, Wis.
George Gorton Machine Co., Racine, Wis.
Greenlee Bros. & Co., Rockford, Ill.
Ideal Commutator Dresser Co., Sycamore, Ill.
Kearney & Trecker Corp., Milwaukee, Wis.
W. B. Knight Machy. Co., St. Louis
Linley Brothers Co., Bridgeport, Conn.
Machinery Mfg. Co., Los Angeles
Moore Special Tool Co., Bridgeport, Conn.
Nichols-Morris Corp., New York
O'Brien Machinery Co., Philadelphia
Pratt & Whitney Co., Hartford, Conn.
Reed-Prentice Corp., Worcester, Mass.
W. A. Schuyler, New York

Broaching

Broaching Machines and Presses

Allsteel Pump Co., Los Angeles
American Broach & Machine Co., Ann Arbor, Mich.
Baldwin Locomotive Works, Eddystone, Pa.
Beatty Machine & Mfg. Co., Hammond, Ind.
John T. Burr & Son, Brooklyn
Cincinnati Milling Machine Co., Cincinnati
Colonial Broach Co., Detroit 7
Dake Engine Co., Grand Haven, Mich.
Davis Keyseater Co., Rochester, N. Y.
Denison Engineering Co., Columbus
Elmes Engineering Works, Chicago
Foote-Burt Co., Cleveland
General Mfg. Co., Detroit
Greenerd Arbor Press Co., Nashua, N. H.
Hannifin Mfg. Co., Chicago
Indianapolis Machinery & Supply Co., Indianapolis, Ind.
K M & H Corp., Fort Wayne, Ind.
Lapointe Machine Tool Co., Hudson, Mass.
Logansport Machine Co., Logansport, Ind.
O'Brien Machinery Co., Philadelphia
Oilgear Co., Milwaukee, Wis.
Reading Machine Co., Reading, Ohio
Rogers Hydraulic, Inc., Minneapolis, Minn.
Sav-Way Industries, Detroit
Standard Machinery Co., Providence, R. I.
Struthers-Wells Corp., Warren, Pa.
Studebaker Machine Co., Maywood, Ill.
Zagar Tool Inc., Cleveland

Drilling

Drills, multi-spindle

Allen Co., Barre, Mass.
Atlas Press Co., Kalamazoo, Mich.
Automatic Machine Co., Bridgeport, Conn.
Avey Drilling Machine Co., Cincinnati
Baird Machine Co., Bridgeport
Baker Brothers, Inc., Toledo, Ohio
Barnes Drill Co., Rockford, Ill.
W. F. & John Barnes, Rockford, Ill.
Baush Machine Tool Co., Springfield, Mass.
Bodine Corp., Bridgeport, Conn.
Boice-Crane Co., Toledo, Ohio
Bradford Machine Tool Co., Cincinnati
Buffalo Forge Co., Buffalo, N. Y.
Buhr Machine Tool Co., Ann Arbor, Mich.
Bullard Co., Bridgeport, Conn.
Canedy Otto Mfg. Co., Chicago Heights, Ill.
Champion Blower & Forge Co., Lancaster, Pa.
Cincinnati Bickford Tool Co., Cincinnati
Cleereman Machine Tool Co., Green Bay, Wis.
Consolidated Machine Tool Corp., Rochester, N. Y.
Cross Co., Detroit
Davis & Thompson Co., Milwaukee, Wis.
Defiance Machine Works, Inc., Defiance, Ohio
Delta Mfg. Co., Milwaukee, Wis.
Ex-Cell-O Corp., Detroit
Foote-Burt Co., Cleveland
Fosdick Machine Tool Co., Cincinnati
Fox Machine Co., Jackson, Mich.
Grant Mfg. & Machine Co., Bridgeport, Conn.
Greenlee Bros. & Co., Rockford, Ill.
Henry & Wright Mfg. Co., Hartford, Conn.
High Speed Hammer Co., Inc., Rochester, N. Y.
Hoefer Mfg. Co., Freeport, Ill.
Index Machinery Co., Cincinnati
Ingersoll Milling Machine Co., Rockford, Ill.
Kaufman Mfg. Co., Manitowoc, Wis.
Kingsbury Machine Tool Co., Keene, N. H.
Langelier Mfg. Co., Providence, R. I.
Leland-Gifford Co., Worcester, Mass.
Lemaire Tool & Mfg. Co., Dearborn, Mich.
W. K. Millholland Machinery Co., Indianapolis, Ind.
Moline Tool Co., Moline, Ill.
National Automatic Tool Co., Inc., Richmond, Ind.
Niles Tool Works, Hamilton, Ohio
Partool Machine Co., Detroit
Pratt & Whitney Div., Hartford, Conn.
Production Machine Co., Greenfield, Mass.
Richards-Badger Packard Co., Milwaukee, Wis.
Rockford Drilling Machine Div., Rockford, Ill.
B. M. Root Co., York, Pa.
Royersford Fdry. & Mach. Co., Inc., Royersford, Pa.
Scherr Co., Inc., New York
Sigourney Tool Co., Hartford, Conn.
Snyder Tool & Engineering Co., Detroit
Sommer & Adams Co., Cleveland
Taylor & Fenn Co., Hartford, Conn.
Thomas Machine Mfg. Co., Pittsburgh
Walker-Turner Co., Inc., Plainfield, N. J.

Drills, radial

American Tool Works Co., Cincinnati
Bryant Machinery & Engineering Co., Chicago
Canedy Otto Mfg. Co., Chicago Heights, Ill.
Carlton Machine Tool Co., Cincinnati
Cincinnati Gilbert Machine Tool Co., Cincinnati
Cleveland Punch & Shear Works Co., Cleveland 14
Foote-Burt Co., Cleveland
Fosdick Machine Tool Co., Cincinnati
General Machinery Corp., Hamilton, Ohio
Hammond Mfg. Co., Cleveland
Heller Machine Co., New York
Leland-Gifford Co., Worcester, Mass.
Moore Machinery Co., San Francisco
Nichols-Morris Corp., New York
O'Brien Machinery Co., Philadelphia
Walker-Turner Co., Inc., Plainfield, N. J.
Western Machine Tool Co., Holland, Mich.

Drills, sensitive

Chas. S. Allen Co., Barre, Mass.
B. C. Ames Co., Waltham, Mass.
Atlas Press Co., Kalamazoo, Mich.
Avey Drilling Machine Co., Cincinnati
Barnes Drill Co., Rockford, Ill.
Boice-Crane Co., Toledo, Ohio
Buffalo Forge Co., Buffalo, N. Y.
Canedy Otto Mfg. Co., Chicago Heights, Ill.
Champion Blower & Forge Co., Lancaster, Pa.
Cincinnati Pulley Machinery Co., Covington, Ky.
Delta Mfg. Co., Milwaukee, Wis.
Edlund Machinery Co., Inc., Cortland, N. Y.
Foote-Burt Co., Cleveland
Fosdick Machine Tool Co., Cincinnati
Graham Mfg. Co., Inc., E. Greenwich, R. I.
R. G. Haskins Co., Chicago
Henry & Wright Mfg. Co., Hartford, Conn.
High Speed Hammer Co., Inc., Rochester, N. Y.
Hole Engineering Service, Detroit
Kingsbury Machine Tool Corp., Keene, N. H.
Langelier Mfg. Co., Providence, R. I.
Leland-Gifford Company, Worcester, Mass.
National Automatic Tool Co., Inc., Richmond, Ind.
National Jet Co., Cumberland, Md.
O'Brien Machinery Co., Philadelphia
Pratt & Whitney Div., W. Hartford, Conn.
Francis Reed Div., Greenfield, Mass.
Royersford Foundry & Machine Co., Royersford, Pa.
Sigourney Tool Co., Hartford, Conn.
Taylor & Fenn Co., Hartford, Conn.
Toledo General Mfg. Co., Toledo, Ohio

Drills, vertical and horizontal

Atlas Press Co., Kalamazoo, Mich.
Aurora Tool Works, Aurora, Ind.
Avey Drilling Machine Co., Cincinnati
Baker Brothers, Inc., Toledo, Ohio
Barnes Drill Co., Rockford, Ill.
W. F. & John Barnes, Rockford, Ill.
Boice-Crane Co., Toledo, Ohio
Bryant Machinery & Engineering Co., Chicago 6
Buffalo Forge Co., Buffalo, N. Y.
Buhr Machine Tool Co., Ann Arbor, Mich.
G. W. Burns Machinery Co., Milwaukee, Wis.
Canedy Otto Mfg. Co., Chicago Heights, Ill.
Champion Blower & Forge Co., Lancaster, Pa.
Cincinnati-Bickford Tool Co., Cincinnati
Cincinnati Gilbert Machine Tool Co., Cincinnati

Jas. Clark, Jr., Electric Co., Inc., Louisville, Ky.
Cleereman Machine Tool Co., Green Bay, Wis.
Consolidated Machine Tool Corp., Rochester 10, N. Y.
Cross Co., Detroit
Davis & Thompson Co, Milwaukee, Wis.
Defiance Machine Works, Inc., Defiance, Ohio
Delta Mfg. Co., Milwaukee 1, Wis.
Donberg-Danits, Chicago
Dumore Co., Racine, Wis.
Edlund Machinery Co., Cortland, N. Y.
Ekstrom, Carlson & Co., Rockford, Ill.
Ex-Cell-O Corp., Detroit
Farnham Mfg. Co., Buffalo, N. Y.
Foote-Burt Co., Cleveland
Fosdick Machine Tool Co., Cincinnati
Frew Machine Co., Philadelphia
General Engineering & Mfg. Co., St. Louis
Giddings & Lewis Machine Tool Co., Fond Du Lac, Wis.
Globe Tapping Machine Co., Bridgeport, Conn.
Hammond Mfg. Co., Milwaukee, Wis.
Hardsocg Mfg. Co., Ottumwa, Iowa
Henry & Wright Mfg. Co., Hartford, Conn.
Ralph Hochman & Co., Newark
Hole Engineering Service, Detroit
Indianapolis Machinery & Supply Co., Indianapolis, Ind.
Ingersoll Milling Machine Co., Rockford, Ill.
Interstate Machinery Co., Chicago
O. S. Kelly Co., Springfield, Ohio
Kent Machine Co., Cuyahoga Falls, Ohio
Keystone Crankshaft & Machine Tool Corp., Erie, Pa.
Kingsbury Machine Tool Corp., Keene, N. H.
H. R. Krueger & Co., Detroit
Langelier Mfg. Co., Providence, R. I.
Lemaire Tool & Mfg. Co., Dearborn, Mich.
Mercury Products Co., Cleveland
W. K. Millholland Machinery Co., Indianapolis, Ind.
National Automatic Tool Company, Inc., Richmond, Ind.
Nichols-Morris Corp., New York
O'Brien Machinery Co., Philadelphia
Oesterlein Machine Co., Cincinnati
Pedrick Tool & Machine Co., Philadelphia
Richards-Badger Packard Co., Milwaukee, Wis.
B. M. Root Co., York, Pa.
Royersford Fdry. & Machine Co., Royersford, Pa.
Ryerson & Son, Inc., Chicago
Wm. Sellers & Co., Inc., Philadelphia
Sheldon Machine Co., Inc., Chicago
Sibley Machine & Fdry. Corp., South Bend, Ind.
Sigourney Tool Co., Hartford, Conn.
Snyder Tool & Engineering Co., Detroit 7
Springfield Machine Tool Co., Springfield, Ohio
Taylor & Fenn Co., Hartford, Conn.
Toledo General Mfg. Co., Toledo, Ohio
Walker-Turner Co., Inc., Plainfield, N. J.
Worthington Pump & Machinery Corp., Harrison, N. J.

Gear Cutting

Gear Cutters

Adams Company, Dubuque, Iowa
Barber-Colman Co., Rockford, Ill.
Bilgram Gear & Machine Works, Philadelphia
Bolsey Machines Corp., New York
Cross Co., Detroit
Farrel-Birmingham Co., Ansonia, Conn.
Fellows Gear Shaper Co., Springfield, Vt.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Inc., Irvington, N. J.
E. F. Hager & Son, Queens Village, N. Y.
Ralph Hochman & Co., Newark
Indianapolis Machinery & Supply Co., Inc., Indianapolis, Ind.
Lees-Bradner Co., Cleveland
Michigan Tool Co., Detroit 12
National Broach & Machine Co., Detroit
Niles Tool Works Co., Hamilton, Ohio
O'Brien Machinery Co., Philadelphia
Producto Machine Co., Bridgeport, Conn.
George Scherr, Co., New York
Sheffield Corp., Dayton 1, Ohio
Stark Tool Co., Waltham, Mass.
H. P. Townsend Mfg. Co., Hartford, Conn.
Triplex Machine Tool Corp., New York
Waltham Machine Works, Waltham, Mass.
D. E. Whiton, Mfg. Co., New London, Conn.

Gear Hobbers

Adams Company, Dubuque, Iowa
Barber-Colman Co., Rockford, Ill.
Cleveland Hobbing Machine Co., Cleveland
Cross Co., Detroit
Gould & Eberhardt, Inc., Irvington, N. J.
Hamilton Tool Co., Hamilton, Ohio
Indianapolis Machinery & Supply Co., Inc., Indianapolis, Ind.
Lees-Bradner Co., Cleveland
Michigan Tool Co., Detroit
Newark Gear Cutting Mach. Co., Newark
O'Brien Machinery Co., Philadelphia
George Scherr Co., New York
Triplex Machine Tool Corp., New York

Gear Shavers

Consolidated Machine Tool Corp., Rochester, N. Y.
Cross Gear & Machine Co., Detroit
Fellows Gear Shaper Co., Springfield, Vt.
Michigan Tool Co., Detroit
National Broach & Machine Co., Detroit
Sheffield Corp., Dayton, Ohio

Grinding

Grinders, abrasive belt

Behr-Manning, Troy, N. Y.
Black & Decker Mfg. Co., Towson, Md.
Boice-Crane Co., Toledo, Ohio
Clizbe Bros. Mfg. Co., Plymouth, Ind.
Defiance Machine Works, Defiance, Ohio
Delta Mfg. Co., Milwaukee, Wis.
Divine Brothers Co., Utica, N. Y.
Hammond Machinery Builders, Inc., Kalamazoo, Mich.
Hill Acme Co., Cleveland
Jones Engineering Co., Ellwood City, Pa.
Mattison Machine Wks., Rockford, Ill.
Mid West Abrasive Co., Detroit
O'Brien Machinery Co., Philadelphia
Oliver Mach. Co., Grand Rapids, Mich.
Porter-Cable Machine Co., Syracuse, N. Y.
Pratt & Whitney Div., Hartford, Conn.
Production Machine Co., Greenfield, Mass.
Standard Electrical Tool Co., Cincinnati
Walker-Turner Co., Inc., Plainfield, N. J.
Walls Sales Corp., New York

Grinders, chucking

Blanchard Machine Co., Cambridge, Mass.
Bryant Chucking Grinder Co., Springfield, Vt.
Cross Co., Detroit 7
Fitchburg Grinding Machine Corp., Fitchburg, Mass.
Grenby Manufacturing Co., Plainville, Conn.
Heald Machine Co., Worcester 6, Mass.
Landis Tool Company, Waynesboro, Pa.
O'Brien Machinery Co., Philadelphia

Grinders, cutter and tool

Abrasive Mach. Tool Co., E. Providence, R. I.
Atlas Press Co., Kalamazoo, Mich.
Baldor Electric Co., St. Louis
Barber-Colman Co., Rockford, Ill.
Edward Blake Co., Newton Centre, Mass.
J. G. Blount Co., Everett, Mass.
H. P. Boggis & Co., Cleveland
Boyar-Schultz Corp., Chicago
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Bryant Chucking Grinder Co., Springfield, Vt.
Carboloy Co., Inc., Detroit
Cincinnati Milling Machine Co., Cincinnati
Chittenden Corp., Cleveland
Cleveland Tool Engineering Co., Cleveland
Continental Machines, Inc., Minneapolis
Covel Mfg. Co., Benton Harbor, Mich.
Davis Boring Tool Co., Div. Larkin-Packer Co., St. Louis
Delta Mfg. Co., Milwaukee 1, Wis.
Detroit Star Grinding Wheel Co., Detroit
Detroit Tap & Tool Co., Detroit 11
Douglas Machinery Co., Inc., New York
Ex-Cell-O Corp., Detroit
Fellows Gear Shaper Co., Springfield, Vt.
Fitchburg Grinding Machine Corp., Fitchburg, Mass.
Gallmeyer & Livingston Co., Grand Rapids, Mich.
Geometric Tool Co., New Haven, Conn.
General Machinery Corp., Boston
Gisholt Machine Co., Madison, Wis.
George Gorton Machine Co., Racine, Wis.
Grobet File Co. of America, New York
Hammond Machinery Builders, Inc., Kalamazoo, Mich.
Hannifin Mfg. Co., Chicago 24
Heald Machine Co., Worcester, Mass.
Hisey-Wolf Machine Co., Cincinnati
Kearney & Trecker Corp., Milwaukee, Wis.
Landis Machine Co., Waynesboro, Pa.
Landis Tool Company, Waynesboro, Pa.
R. K. LeBlond Machine Tool Co., Cincinnati
K. O. Lee Co., Aberdeen, S. D.
Mercury Products Co., Cleveland 14
W. F. Meyers Co., Inc., Bedford, Ind.
Mummert-Dixon Co., Hanover, Pa.
National Acme Co., Cleveland
Norton Company, Worcester 6, Mass.
O'Brien Machinery Co., Philadelphia
Oliver Instrument Co., Adrian, Mich.
Onsrud Machine Works, Chicago
Oster Mfg. Co., Cleveland 3
Pratt & Whitney Div., Hartford, Conn.
Precision Gage & Tool Co., Dayton, Ohio
H. P. Preis Engraving Mach. Co., Newark
Production Machine Co., Greenfield, Mass.
Samuel C. Rogers, Buffalo, N. Y.
Geo. Scherr Co., Inc., New York
Wm. Sellers & Co., Philadelphia
Standard Electric Tool Co., Cincinnati
Standard Tool Co., Cleveland
Stanley Elec. Tool Div. of Stanley Works, New Britain, Conn.
Sundstrand Machine Tool Co., Rockford, Ill.
T. G. M. Mfg. Co., Harrison, N. J.
Thompson Grinder Co., Springfield
Union Twist Drill Co., Athol, Mass.
U. S. Electric Tool Co., Cincinnati
O. S. Walker Co., Worcester, Mass.
Wickman Corp., Detroit
Willey's Carbide Tool Co., Detroit

Grinders, cylindrical

Arter Grinding Machine Co., Worcester, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Bryant Chucking Grinder Co., Springfield, Vt.
Cincinnati Electric Tool Co., Cincinnati
Cincinnati Grinders Inc., Cincinnati
Cleveland Tool Engineering Co., Cleveland
Delta Mfg. Co., Milwaukee 1, Wis.
Douglas Machinery Co., Inc., New York
Dumore Co., Racine, Wis.
Farrel-Birmingham Co., Ansonia, Conn.
Fitchburg Grinding Machine Corp., Fitchburg, Mass.
Garrison Machine Works, Inc., Dayton, Ohio
Grenby Manufacturing Co., Plainville, Conn.
Heald Machine Co., Worcester 6, Mass.
Hisey-Wolf Machine Co., Cincinnati
Landis Tool Company, Waynesboro, Pa.
H. Leach Machinery Co., Providence, R. I.
K. O. Lee Company, Aberdeen, S. D.
Lempco Products, Inc., Bedford, Ohio
Morse Twist Drill & Machine Co., New Bedford, Mass.
Norton Co., Worcester, Mass.
O'Brien Machinery Co., Philadelphia
Precise Products Co., Racine, Wis.
Sheffield Corp., Dayton, Ohio
Standard Electrical Tool Co., Cincinnati
Thompson Grinder Co., Springfield, Ohio
Yoder Co., Cleveland

Grinders, disk

Charles H. Besly & Co., Chicago
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Cincinnati Electric Tool Co., Cincinnati
Cleveland Electric Motor Co., Cleveland
Delta Mfg. Co., Milwaukee 1, Wis.
Diamond Machine Co., Providence, R. I.
Dumore Company, Racine, Wis.
Fitchburg Grinding Machine Corp., Fitchburg, Mass.
Gardner Machine Co., Beloit, Wis.
Hammond Machinery Bldrs., Inc., Kalamazoo, Mich.
Hanchett Mfg. Co., Big Rapids, Mich.
Hisey-Wolf Machine Co., Cincinnati

Independent Pneumatic Tool Co., Chicago 6
Lempco Products, Inc., Bedford, Ohio
Millers Falls Co., Greenfield, Mass.
O'Brien Machinery Co., Philadelphia
Oliver Machine Co., Grand Rapids, Mich.
Porter Cable Machine Co., Syracuse, N. Y.
Pratt & Whitney Div., Hartford, Conn.
Production Machine Co., Greenfield, Mass.
Queen City Machine Tool Co., Cincinnati
Standard Electrical Tool Co., Cincinnati
U. S. Electric Tool Co., Cincinnati
Walker-Turner Co., Plainfield, N. J.
Walls Sales Corp., New York

Grinders, gear

Arter Grinding Machine Co., Worcester, Mass.
Bradley Machinery Co., Detroit
Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn.
Cosa Corp., New York
Cross Co., Detroit 7
Fellows Gear Shaper Co., Springfield, Vt.
Fitchburg Grinding Machine Corp., Fitchburg, Mass.
Gear Grinding Machine Co., Detroit
Gleason Works, Rochester, N. Y.
Indianapolis Machinery & Supply Co., Inc., Indianapolis, Ind.
Lees-Bradner Co., Cleveland
National Broach & Machine Co., Detroit
O'Brien Machinery Co., Philadelphia
Pratt & Whitney Div., Hartford, Conn.
Process Gear & Machine Co., Detroit
Triplex Machine Tool Corp., New York
Vinco Corp., Detroit

Grinders, internal

Arter Grinding Machine Co., Worcester, Mass.
Baird Machinery Co., Bridgeport, Conn.
Bryant Chucking Grinder Co., Springfield, Vt.
Crystal Lake Machine Works, Crystal Lake, Ill.
Douglas Machinery Co., Inc., New York
Fitchburg Grinding Machine Corp., Fitchburg, Mass.
Grenby Manufacturing Co., Plainville, Conn.
Hartford Special Machinery Co., Hartford, Conn.
Heald Machine Co., Worcester, Mass.
Landis Tool Co., Waynesboro, Pa.
Lempco Products, Inc., Bedford, Ohio
Majestic Tool & Mfg. Co., Detroit
Marburg Bros., Inc., New York
O'Brien Machinery Co., Philadelphia
Rivett Lathe Grinders, Inc., Brighton, Boston
Sav-Way Industries, Detroit
Standard Electrical Tool Co., Cincinnati
Sundstrand Machine Tool Co., Rockford, Ill.
Taylor & Fenn Co., Hartford, Conn.
Thompson Grinder Co., Springfield, Ohio
Van Norman Machine Tool Co., Springfield, Mass.
O. S. Walker Co., Worcester, Mass.
Wicaco Machine Corp., Philadelphia

Grinders, surface

Abrasive Machine Tool Co., E. Providence, R. I.
Arter Grinding Machine Co., Worcester, Mass.
Atlantic Machinery Co., New York
Baker Brothers, Inc., Toledo, Ohio
Bergram Mech. Engineering Co., New Britain, Conn.
Charles H. Besly & Co., Chicago
Blanchard Machine Co., Cambridge, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Builders Iron Foundry, Providence, R. I.
Champion Blower & Forge Co., Lancaster, Pa.
Cincinnati Milling Machine Co., Cincinnati
Jas. Clark, Jr., Electric Co., Inc., Louisville, Ky.
Clizbe Bros. Mfg. Co., Plymouth, Ind.
Continental Machines Inc., Minneapolis 4, Minn.
Covel Mfg. Co., Benton Harbor, Mich.
Cross Co., Detroit 7
Crozier Machine Tool Co., Hawthorne, Cal.
Delta Mfg. Co., Milwaukee 1, Wis.
DoAll Co., Minneapolis, Minn.
Douglas Machinery Co., Inc., New York
Ex-Cell-O Corp., Detroit
Foote-Burt Co., Cleveland
Gallmeyer & Livingston Co., Grand Rapids, Mich.
Gardner Machine Co., Beloit, Wis.
Hammond Machinery Builders, Inc., Kalamazoo, Mich.
Hammond Mfg. Co., Cleveland
Hanchett Mfg. Co., Big Rapids, Mich.
R. G. Haskins Co., Chicago
Heald Machine Co., Worcester 6, Mass.
Hill Acme Co., Cleveland
Hisey-Wolf Machine Co., Cincinnati
Jefferson Machine Tool Co., Cincinnati
Landis Tool Co., Waynesboro, Pa.
H. Leach Machinery Co., Providence, R. I.
Majestic Tool & Mfg. Co., Detroit
Mattison Machine Wks., Rockford, Ill.
Mummert-Dixon Co., Hanover, Pa.
Murchey Machine & Tool Co., Detroit
Nichols-Morris Corp., New York
Norton Company, Worcester 6, Mass.
O'Brien Machinery Co., Philadelphia
Portman Machine Tool Co., Mt. Vernon, N. Y.
Pratt & Whitney Div., Hartford, Conn.
Production Machine Co., Greenfield, Mass.
Reid Brothers Co., Inc., Beverly, Mass.
Robot Machinery Corp., Brooklyn
Schauer Machine Co., Cincinnati
Sheffield Corp., Dayton, Ohio
Standard Electrical Tool Co., Cincinnati
Thompson Grinder Co., Springfield, Ohio
Van Norman Machine Tool Co., Springfield, Mass.
O. S. Walker Co., Worcester, Mass.
Wesson Co., Detroit
Williams, White & Co., Moline, Ill.

Grinders, thread

Dalzen Tool & Mfg. Co., Detroit
Ex-Cell-O Corp., Detroit
Jones & Lamson Machine Co., Springfield, Vt.
Landis Tool Company, Waynesboro, Pa.
Landis Machine Co., Waynesboro, Pa.
Sheffield Corp., Dayton, Ohio
Triplex Machine Tool Corp., New York
Walz & Krenzer, Inc., Rochester, N. Y.

Lathes

Lathes, chucking

Acme Machine Tool Co., Cincinnati
Baird Machine Co., Stratford, Conn.
Bullard Co., Bridgeport, Conn.
Cincinnati Lathe & Tool Co., Cincinnati
Cone Automatic Machine Co., Inc., Windsor, Vt.
Cross Co., Detroit 7
G. M. Diehl Machine Works, Inc., Wabash, Ind.
Gisholt Machine Co., Madison 3, Wis.
Goss & DeLeeuw Machine Co., New Britain, Conn.
Indianapolis Machinery & Supply Co., Indianapolis, Ind.
Jones & Lamson Machine Co., Springfield, Vt.
R. K. LeBlond Machine Tool Co., Cincinnati
Lehmann Machine Co., St. Louis, Mo.
Lipe-Rollway Corp., Syracuse, N. Y.
National Acme Co., Cleveland 8
Nichols-Morris Corp., New York
O'Brien Machinery Co., Philadelphia
Oster Mfg. Co., Cleveland 3
Potter & Johnston Machine Co., Pawtucket, R. I.
Sheldon Machine Co., Chicago
South Bend Lathe Works, South Bend, Ind.
Standard Electrical Tool Co., Cincinnati
Sundstrand Machine Tool Co., Rockford, Ill.
Warner & Swasey Co., Cleveland 3

Lathes, engine and toolroom

American Tool Works Co., Cincinnati
B. C. Ames Co., Waltham, Mass.
Atlas Press Co., Kalamazoo, Mich.
Axelson Mfg. Co., Los Angeles
Boye & Emmes Machine Tool Co., Cincinnati
Bradford Machine Tool Co., Cincinnati
Brown & Sharpe Mfg. Co., Providence 1, R. I.
Bullard Co., Bridgeport 2, Conn.
F. W. Burns Machinery Co., Milwaukee, Wis.
Carroll & Jamieson Machine Tool Co., Batavia, Ohio
Cincinnati Lathe & Tool Co., Cincinnati
Clausing Mfg. Co., Ottumwa, Iowa
Consolidated Machine Tool Corp., Rochester 10, N. Y.
D & M Machine Works, Torrance, Cal.
Delta Equipment Co., Philadelphia
Enterprise Co., Columbiana, Ohio
Faris Pump & Mfg. Co., Indianapolis, Ind.
Fay & Scott, Dexter, Maine
Gisholt Machine Co., Madison 3, Wis.
Hardinge Brothers, Inc., Elmira, N. Y.
Hendey Machine Co., Torrington, Conn.
Indianapolis Machinery & Supply Co., Indianapolis, Ind.
Interstate Machinery Co., Inc., Chicago
Jones & Lamson Machine Co., Springfield, Vt.
Keystone Crankshaft & Machine Tool Corp., Erie, Pa.
H. Leach Machinery Co., Providence, R. I.
R. K. LeBlond Machine Tool Co., Cincinnati
Lehmann Machine Co., Chicago 30
Lodge & Shipley Machine Tool Co., Cincinnati
Logan Engineering Co., Chicago
Mackintosh-Hemphill Co., Pittsburgh
McCabe Machinery Co., Larchmont, N. Y.
Monarch Machine Tool Co., Sidney, Ohio
Nebel Machine Tool Co., Cincinnati
Nichols-Morris Corp., New York
Niles Tool Works Co., Hamilton, Ohio
O'Brien Machinery Co., Philadelphia
Porter, McLeod Machine Tool Co., Inc., Hatfield, Mass.
Pratt & Whitney Div., Hartford, Conn.
Reed-Prentice Corp., Worcester, Mass.
Rivett Lathe & Grinder Inc., Brighton, Mass.
Rogers Machine Works, Inc., Buffalo, N. Y.
San Francisco Engineering Co., San Francisco
Sebastian Lathe Co., Cincinnati
Wm. Sellers & Co. Inc., Philadelphia 30
Seneca Falls Machine Co., Seneca Falls, N. Y.
Sheffield Corp., Dayton 1, Ohio
Sommerfeld Machine Co., Braddock, Pa.
South Bend Lathe Works, South Bend 22, Ind.
Springfield Machine Tool Co., Springfield, Ohio
Sundstrand Machine Tool Co., Rockford, Ill.
Waterville Iron Works, Waterville, Me.
Western Machine Tool Works, Holland, Mich.
Wickes Bros., Saginaw, Mich.

Lathes, turret

Acme Machine Tool Co., Cincinnati
Brown & Sharpe Mfg. Co., Providence 1, R. I.
Bullard Co., Bridgeport, Conn.
F. W. Burns Machinery Co., Milwaukee, Wis.
Cincinnati Lathe & Tool Co., Cincinnati
Cone Automatic Machine Co., Windsor, Vt.
Diehl Machine Works, Inc., Wabash, Ind.
Donberg-Danits, Chicago
Failor-Strafer Machinery Co., Jersey City, N. J.
Gisholt Machine Co., Madison 3, Wis.
Globe Products Mfg. Co., Los Angeles
Hardinge Bros., Inc., Elmira, N. Y.
Hasco Machinery Co., Newark
Ralph Hochman & Co., Newark
Indianapolis Machinery & Supply Co., Inc., Indianapolis, Ind.
Interstate Machinery Co., Inc., Chicago
Jones & Lamson Machine Co., Springfield, Vt.
R. K. LeBlond Machine Tool Co., Cincinnati
Lipe-Rollway Corp., Syracuse, N. Y.
Logan Engineering Co., Chicago
J. L. Lucas & Son, Inc., Bridgeport, Conn.
W. K. Millholland Machinery Co., Indianapolis, Ind.
Morey Machinery Co., Inc., New York
Nichols-Morris Corp., New York
O'Brien Machinery Co., Philadelphia
Oster Mfg. Co., Cleveland 3
Potter & Johnston Machine Co., Pawtucket, R. I.
Rivett Lathe & Grinder, Inc., Brighton, Mass.
Rogers Machine Works, Alfred, N. J.
South Bend Lathe Works, South Bend 22, Ind.
Springfield Machine Tool Co., Springfield, Ohio
Stark Tool Co., Waltham, Mass.
Stewart Machine Tool Co., Paterson, N. J.
H. P. Townsend Mfg. Co., Hartford, Conn.
Warner & Swasey Co., Cleveland

Screw Machines

Acme Machine Tool Co., Cincinnati
Billings & Spencer Co., Hartford, Conn.
E. W. Bliss Co., Brooklyn
Bodine Corp., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clark-Aiker Co., Lee, Mass.
Clausing Mfg. Co., Ottumwa, Iowa
Cleveland Automatic Machine Co., Cleveland
Cone Automatic Machine Co., Inc., Windsor, Vt.
Cosa Corp., New York
Davenport Machine Tool Co., Inc., Rochester, N. Y.

George L. Detterbeck Co., Inc., Chicago
Dica, Inc., New York
Economy Engineering Co., Willoughby, Ohio
Foote-Burt Co., Cleveland
Geometric Tool Co., New Haven, Conn.
Gisholt Machine Co., Madison, Wis.
Globe Products Mfg. Co., Los Angeles
George Gorton Machine Co., Racine, Wis.
Greenlee Bros. & Co., Rockford, Ill.
E. F. Hager & Son, New York
Hardinge Brothers, Inc., Elmira, N. Y.
Hasco Machine Co., Newark
Hause Valve Co., Montpelier, Ohio
Ralph Hochman & Co., Newark
Indianapolis Machinery & Supply Co., Indianapolis, Ind.
E. J. Manville Machine Co., Inc., Tiffin, Ohio
National Acme Company, Cleveland 8
Nichols-Morris Corp., New York
Oster Mfg. Co., Cleveland 3
Pawtucket Mfg. Co., Pawtucket, R. I.
George Scherr Co., New York
Sheffield Corp., Dayton 1, Ohio
John B. Stevens, Inc., New York
Stewart Machine Tool Co., Paterson, N. J.
C. I. Togstad, Co., Kokomo, Ind.
Toledo Machine & Tool Div., E. W. Bliss Co., Toledo, Ohio
H. P. Townsend Mfg. Co., Hartford, Conn.
Triplex Machine Tool Corp., New York
Wade Tool Co., Waltham, Mass.
Warner & Swasey Co., Cleveland
Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.
Wickman Corp., Detroit

Milling

Millers, die sinking

B. C. Ames Co., Waltham, Mass.
Blank & Buxton Machinery Co., Jackson, Mich.
Bridgeport Machines, Inc., Bridgeport, Conn.
Cincinnati Milling Machine Co., Cincinnati
Douglas Machinery Co., Inc., New York
Ekstrom, Carlson, & Co., Rockford, Ill.
Fray Machine Tool Co., Glendale, Cal.
Giddings & Lewis Machine Tool Co., Toledo, Ohio
George Gorton Machine Co., Racine, Wis.
Hardinge Brothers, Elmira, N. Y.
Ingersoll Milling Mach. Co., Rockford, Ill.
Jackson Machine & Tool Co., Jackson, Mich.
Kearney & Trecker Corp., Milwaukee, Wis.
Kent-Owens Machine Co., Toledo, Ohio
O'Brien Machinery Co., Philadelphia
Sheldon Machine Co., Chicago
H. W. Spiegel Co., Detroit
Thurston Mfg. Co., Providence, R. I.
Turchan Follower Machine, Detroit
Univertical Machine Co., Detroit
Van Norman Co., Springfield, Mass.

Millers, plain, horizontal

B. C. Ames, Co., Waltham, Mass.
Benchmaster Mfg. Co., Los Angeles
C. C. Bradley, Co., Syracuse, N. Y.
Brown & Sharpe Mfg. Co., Providence, R. I.
Burke Machine Tool Co., Conneaut, Ohio
F. W. Burns Machinery Co., Milwaukee, Wis.
Cincinnati Milling Machine Co., Cincinnati
Coastal Machine Works, Bridgeport, Conn.
Davis & Thompson Co., Milwaukee, Wis.
Diamond Tool Co., Los Angeles
Douglas Machinery Co., Inc., New York
Espen-Lucas Mach. Wks., Philadelphia
Failor-Strafer Machinery Co., Jersey City, N. J.
Fray Machine Tool Co., Glendale, Cal.
General Engineering & Mfg. Co., St. Louis
Giddings & Lewis Machine Tool Co., Fond Du Lac, Wis.
Greaves Machine Tool Co., Cincinnati
Hardinge Brothers, Inc., Elmira, N. Y.
Ralph Hochman & Co., Newark
Jackson Machine & Tool Co., Jackson, Mich.
Jefferson Machine Tool Co., Cincinnati
Jois Machinery Co., New York
Kearney & Trecker Corp., Milwaukee, Wis.
Kempsmith Machine Co., Milwaukee, Wis.
Kent-Owens Machine Co., Toledo, Ohio
Keystone Crankshaft & Machine Tool Corp., Erie, Pa.
H. Leach Machinery Co., Providence, R. I.
Miller & Crowningshield, Greenfield, Mass.
Nichols-Morris Corp., New York
O'Brien Machinery Co., Philadelphia
Oesterlein Machine Co., Cincinnati
Ohio Machine Tool Co., Kenton, Ohio
Sheldon Machine Co., Inc., Bridgeport, Conn.
Stark Tool Co., Waltham, Mass.
Stewart Machine Tool Co., Paterson, N. J.
Van Norman Co., Springfield, Mass.

Millers, plain, vertical

Acme Tool Co., New York
Benchmaster Mfg. Co., Los Angeles
Blank & Buxton Machinery Co., Jackson, Mich.
Bridgeport Machines, Inc., Bridgeport, Conn.
Browne & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati
Cochrane Bly Co., Rochester, N. Y.
Consolidated Machine Corp., Rochester, N. Y.
James Coulter Machine Co., Bridgeport, Conn.
Davis & Thompson Co., Milwaukee, Wis.
Ekstrom, Carlson & Co., Rockford, Ill.
Fray Machine Tool Co., Glendale, Cal.
General Machinery Corp., Hamilton, Ohio
George Gorton Machine Co., Racine, Wis.
Granite State Machine Co., Inc., Manchester, N. H.
Hardinge Bros., Inc., Elmira, N. Y.
Ingersoll Milling Machine Co., Rockford, Ill.
Jefferson Machine Tool Co., Cincinnati
Kearney & Trecker Corp., Milwaukee, Wis.
Kempsmith Mfg. Co., Milwaukee, Wis.
Kent-Owens Machine Co., Toledo, Ohio
W. B. Knight Machy. Co., St. Louis
H. Leach Machinery Co., Providence, R. I.
Lindley Bros. Co., Bridgeport, Conn.
Lombard Governor Co., Ashland, Mass.
Machinery Mfg. Co., Los Angeles
Miller Engineering & Machine Co., Newark
Morey Machinery Co., Inc., New York
Nichols-Morris Corp., New York
O'Brien Machinery Co., Philadelphia
Pratt & Whitney Div., Hartford, Conn.
Producto Machine Co., Bridgeport, Conn.
Reed-Prentice Corp., Worcester, Mass.
Rusnok Tool Works, Chicago
Shields Mfg. Co., Long Island City, N. Y.
Sidney Machine Tool Co., Sidney, Ohio
Sommer & Adams Co., Cleveland
Stark Tool Co., Waltham, Mass.
Sundstrand Machine Tool Co., Rockford, Ill.
U. S. Tool Co., Inc., East Orange, N. J.
Van Norman Co., Springfield, Mass.

Millers, profiling

Automatic Machine Co., Bridgeport, Conn.
Cincinnati Milling Machine Co., Cincinnati
Consolidated Machine Tool Corp., Rochester, N. Y.
Farnham Mfg. Co., Buffalo, N. Y.
Frew Machine Co., Philadelphia
George Gorton Machine Co., Racine, Wis.
W. B. Knight Machinery Co., St. Louis
H. Leach Machinery Co., Providence, R. I.
Miller Engineering & Machine Co., Newark
Morey Machinery Co., Inc., New York
Nichols-Morris Corp., New York
O'Brien Machinery Co., Philadelphia
Pratt & Whitney Div., Hartford, Conn.
H. P. Preis Engraving Machine Co., Newark
Producto Machine Co., Bridgeport, Conn.
Reed-Prentice Corp., Worcester, Mass.
Sundstrand Machine Tool Co., Rockford, Ill.
Earl A. Thompson Mfg. Co., Ferndale, Mich.
Wade Tool Co., Waltham, Mass.

Millers, thread

Adams Co., Dubuque, Iowa
Automatic Machine Co., Bridgeport, Conn.
Cleveland Automatic Mach. Co., Cleveland
James Coulter Machine Co., Bridgeport, Conn.
Delaware Machinery Corp., New York
Ex-Cell-O Corp., Detroit
Fray Machine Tool Co., Glendale, Cal.
General Engineering & Mfg. Co., St. Louis
R. Gordon Co., Royal Oak, Mich.
Hall Planetary Co., Philadelphia
Hanson-Whitney Machine Co., Hartford, Conn.
Indianapolis Machinery & Supply Co., Inc., Indianapolis, Ind.
Lees-Bradner Co., Cleveland
Marburg Brothers Inc., New York
Master Mfg. Co., Hutchinson, Kansas
Murchey Machine & Tool Co., Detroit 26
Plan-O-Mill Corp., Royal Oak, Mich.
Pratt & Whitney Div., Hartford, Conn.
Producto Machine Co., Bridgeport, Conn.
Rivett Lathe & Grinders, Inc., Brighton, Boston
Geo. Scherr Co., Inc., New York
Smalley General Co., Bay City, Mich.
Sommer & Adams Co., Cleveland
T. M. C. Mfg. Co., Harrison, N. J.
Taft-Pierce Mfg. Co., Woonsocket, R. I.
Waltham Machine Works, Waltham, Mass

Millers, universal

Brown & Sharpe Mfg. Co., Providence, R. I.
Burke Machine Tool Co., Conneaut, Ohio
F. W. Burns Machinery Co., Milwaukee, Wis.
Cincinnati Milling Machine Co., Inc., Cincinnati
Dica, Inc., New York
Douglas Machinery Co., Inc., New York
Elgin Tool Works, Chicago
Fray Machine Tool Co., Glendale, Cal.
George Gorton Machine Co., Racine, Wis.
Greaves Machine Tool Co., Cincinnati
Hardinge Brothers, Elmira, N. Y.
Ralph Hochman & Co., Newark
Kearney & Trecker Corp., Milwaukee, Wis.
Kempsmith Machine Co., Milwaukee, Wis.
Keystone Crankshaft & Machine Tool Corp., Erie, Pa.
H. Leach Machinery Co., Providence, R. I.
New Britain-Gridley Machine Div., New Britain Machine Co., New Britain, Conn.
O'Brien Machinery Co., Philadelphia
Robot Machinery Co., Brooklyn
Sheldon Machine Co., Chicago
Shields Mfg. Co., Inc., Long Island City, N. Y.
Stewart Machine Tool Co., Paterson, N. J.
Terminal Machinery Co., Boston
Van Norman Company, Springfield, Mass.

Planing

Planers

Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia 42
Benchmaster Mfg. Co., Los Angeles
Cincinnati Planer Co., Cincinnati
Cleveland Planer Co., Cleveland
Cleveland Punch & Shear Works Co., Cleveland 14
Consolidated Machine Tool Corp., Rochester 10, N. Y.
General Engineering & Mfg. Co., St. Louis
G. A. Gray Co., Cincinnati
Interstate Machinery Co., Inc., Chicago
Liberty Planers, Inc., Hamilton, Ohio
J. L. Lucas & Son, Inc., Bridgeport, Conn.
Mesta Machine Co., Pittsburgh 30
Morton Manufacturing Co., Muskegon Heights, Mich.
Nichols-Morris Corp., New York
O'Brien Machinery Co., Philadelphia
Ohio Machine Tool Co., Kenton, Ohio
Rockford Machine Tool Co., Rockford, Ill.
William Sellers & Co. Inc., Philadelphia 30
Stewart Machine Tool Co., Paterson, N. J.
H. B. Underwood Corp., Philadelphia

Reaming, Honing and Lapping

Honing Machines

All American Tool & Mfg. Co., Chicago
Automotive Maintenance Machinery Co., No. Chicago, Ill.
Barnes Drill Co., Rockford, Ill.
W. F. & John Barnes, Rockford, Ill.
Cross Co., Detroit
Enterprise Machine Parts Corp., Detroit
C. Allen Fulmer Co., Cincinnati
Greaves Machine Tool Co., Inc., Cincinnati
Hole Engineering Service, Detroit
Micromatic Hone Corp., Detroit
Moline Tool Co., Moline, Ill.
A. P. Schraner, Cleveland
Snyder Tool & Engineering Co., Detroit 7
Sunnen Products Co., St. Louis

Lapping Machines

Barnes Drill Co., Rockford, Ill.
Brody & Watson, Cambridge, Mass.
Cincinnati Grinders Inc., Cincinnati
Dalzen Tool & Mfg. Co., Detroit
Ex-Cell-O Corp., Detroit
Fellows Gear Shaper Co., Springfield, Vt.
Franklin Machine & Fdry. Co., Providence, R. I.
C. Allen Fulmer Co., Cincinnati
Gardner Machine Co., Beloit, Wis.
Gear Processing Works, Cleveland
Grob Brothers, Grafton, Wis.
International Detrola Corp., Elkhart, Ind.
National Broach & Machine Co., Detroit 13
Norton Co., Worcester 6, Mass.
Roos Tool & Mfg. Co., Montclair, N. J.
Schauer Machine Co., Cincinnati
A. P. Schraner & Co., Cleveland
Triplex Machine Tool Corp., New York
Ultra-Lap Machine Co., Detroit
Vinco Corp., Detroit

Reaming Machines

Automotive Maintenance Machinery, Chicago
Baker Brothers, Inc., Toledo, Ohio
Barber-Colman Co., Rockford, Ill.
Barnes Drill Co., Rockford, Ill.
W. F. & John Barnes, Rockford, Ill.
Builders Iron Foundry, Providence, R. I.
Bullard Co., Bridgeport, Conn.
Cincinnati Electrical Tool Co., Cincinnati
Cross Co., Detroit
Foote-Burt Co., Cleveland
Helwig Mfg. Co., St. Paul, Minn.
Independent Pneumatic Tool Co., Chicago
Ingersoll-Rand Co., New York
K M & H Corp., Fort Wayne, Ind.
Kaufman Mfg. Co., Manitowoc, Wis.
H. R. Krueger & Co., Detroit
Lakeside Bridge & Steel Co., Milwaukee, Wis.
K. O. Lee Co., Aberdeen, S. D.
Lemaire Tool & Mfg. Co., Dearborn, Mich.
Moline Tool Co., Moline, Ill.
National Automatic Tool Co., Inc., Richmond, Ind.
Pines Engineering Co., Inc., Aurora, Ill.
Pratt & Whitney Div., Hartford, Conn.
Snyder Tool & Engineering Co., Detroit
Stow Mfg. Co., Binghamton, N. Y.
Taft-Pierce Mfg. Co., Woonsocket, R. I.

Shaping

Shapers

American Tool Works, Co., Cincinnati
B. C. Ames Co., Waltham, Mass.
E. C. Atkins & Co., Indianapolis
Atlas Press Co., Kalamazoo, Mich.
Automotive Maintenance Machinery Co., No. Chicago, Ill.
Baldwin-Southwark Div., Baldwin Locomotive Works, Philadelphia 42
Bryant Machinery & Engineering Co., Chicago
Cincinnati Shaper Co., Cincinnati
Cleveland Punch & Shear Works Co., Cleveland 14
Cochrane Bly Co., Rochester, N. Y.
Columbia Machine Tool Co., Hamilton, Ohio
General Engineering & Mfg. Co., St. Louis
Gould & Eberhardt, Inc., Irvington, N. J.
Hanson-Whitney Machine Co., Hartford, Conn.
Hendey Machine Co., Torrington, Conn.
Indian White Eagle Engineering & Machine Works, Brooklyn
Jones Machine Tool Wks., Inc., Philadelphia
Lewis Machine Tool Co., Los Angeles
Machinery Mfg. Co., Los Angeles
Marburg Bros., Inc., New York
Mesta Machine Co., Pittsburgh 30
Morey Machinery Co., Inc., New York
Morton Mfg. Co., Muskegon Hts., Mich.
Nichols-Morris Corp., New York
Nixon Gear & Mach. Co., Syracuse, N. Y.
O'Brien Machinery Co., Philadelphia
Ohio Machine Tool Co., Kenton, Ohio
Pratt & Whitney Div., Hartford, Conn.
Reed-Prentice Corp., Worcester, Mass.
Rhodes Mfg. Co., Waltham, Mass.
Rockford Machine Tool Co., Rockford, Ill.
Sales Service Machine Tool Co., St. Paul, Minn.
Smith & Mills Co., Cincinnati
Walker-Turner Co., Inc., Plainsfield, N. J.
Western Machine Tool Wks., Holland, Mich.

Threading and Tapping

Threading Machines

Brown & Sharpe Mfg. Co., Providence, R. I.
Davis & Thompson Co., Milwaukee, Wis.
Eastern Machine Screw Corp., New Haven, Conn.
Fellows Gear Shaper Co., Springfield, Vt.
Geometric Tool Co., New Haven, Conn.
Hill Acme Co., Cleveland
Jones & Lamson Machine Co., Springfield, Vt.
Kaufman Mfg. Co., Manitowoc, Wis.
Landis Machine Co., Inc., Waynesboro, Pa.
Murchey Machine & Tool Co., Detroit
O'Brien Machinery Co., Philadelphia
Oster Mfg. Co., Cleveland 3
Plan-O-Mill Corp., Hazel Park, Mich.
Procunier Safety Chuck Co., Chicago
Toledo Machine & Tool Co., Toledo, Ohio
Warner & Swasey Co., Cleveland

Tapping Machines

Alto Mfg. Co., Chicago
Avey Drilling Machine Co., Cincinnati
Barnes Drill Co., Rockford, Ill.
W. F. & John Barnes, Rockford, Ill.
Baush Machine Tool Co., Springfield, Mass.
Black & Decker Mfg. Co., Towson, Md.
Bodine Corp., Bridgeport, Conn.
Boice-Crane Co., Toledo Ohio
Bradford Machine Tool Co., Cincinnati
Brand Tool & Supply Co., Los Angeles
Buffalo Forge Co., Buffalo, N. Y.
Chicago Pneumatic Tool Co., New York
Cincinnati Electrical Tool Co., Cincinnati
Cleveland Tapping Machine Co., Cincinnati
Cross Co., Detroit
Defiance Machine Works, Inc., Defiance, Ohio
Detroit Tap & Tool Co., Detroit
Dorman Machine Tool Works, New York
Douglas Machinery Co., Inc., New York
Edlund Machinery Co., Inc., Cortland, N. Y.
Ettco Tool Co., Inc., Brooklyn
Foote-Burt Co., Cleveland
Frew Machine Co., Philadelphia
Geometric Tool Co., New Haven, Conn.
Globe Tapping Machine Co., Bridgeport, Conn.
Greenlee Bros., & Co., Rockford, Ill.
Hamilton Tool Co., Hamilton Ohio
Hasco Machinery Co., Newark
R. G. Haskins Co., Chicago
Helwig Mfg. Co., St. Paul, Minn.
Hill Acme Co., Cleveland
Hunter Engineering Co., Riverside Cal.
Independent Pneumatic Tool Co., Chicago
Ingersoll Milling Machine Co., Rockford, Ill.
Charles L. Jarvis Co., Middletown, Conn.
K M & H Corp., Fort Wayne, Ind.
Kaufman Mfg. Co., Manitowoc, Wis.
Kent Machine Co., Cuyahoga Falls, Ohio
Kingsbury Machine Tool Corp., Keene, N. H.
Langelier Mfg. Co., Providence, R. I.
Leland-Gifford Co., Worcester, Mass.
Lemaire Tool & Mfg. Co., Dearborn, Mich.
W. K. Millholland Machinery Co., Indianapolis
Mitchell Engineering Co., Springfield, Ohio
Moline Tool Co., Moline, Ill.
Murchey Machine & Tool Co., Detroit
National Automatic Tool Co., Inc., Richmond, Ind.
National Machinery Co., Tiffin, Ohio
O'Brien Machinery Co., Philadelphia
Oesterlein Machine Co., Cincinnati
E. O. Partridge, Chicago
Pines Engineering Co., Inc., Aurora, Ill.
Plan-O-Mill Corp., Hazel Park, Mich.
Procunier Safety Chuck Co., Chicago
Producto Machine Co., Bridgeport, Conn.
Rehuberg-Jacobson Mfg. Co., Inc., Rockford, Ill.
San Francisco Engineering Co., San Francisco
Snyder Tool & Eng. Co., Detroit 7
Stark Tool Co., Waltham, Mass.
Stewart Machine Co., Waltham, Mass.
H. P. Townsend Mfg. Co., Hartford, Conn.
United Engineering & Foundry Co., Pittsburgh
Walker-Turner Co., Inc., East Plainfield, N. J.
Warner & Swasey Co., Cleveland
Waterbury, Farrel Foundry & Machine Co., Waterbury, Conn.
Western Machine Tool Works, Holland, Mich.

Special Purpose Machines

American Shear Knife Co., Homestead, Pa.
W. F. & John Barnes, Rockford, Ill.
Bicknell-Thomas Co., Greenfield, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Clinton Machine Co., Clinton, Mich.
Cochrane Bly Co., Rochester, N. Y.
Cross Co., Detroit
Davis & Thompson Co., Milwaukee, Wis.
Espen-Lucas Machine Works, Philadelphia
Ex-Cell-O Corp., Detroit
Farnham Mfg. Co., Buffalo, N. Y.
Farrel-Birmingham Co., Inc., Ansonia, Conn.
Fitchburg, Grinding Machine Corp., Fitchburg, Mass.
George Gorton Machine Co., Racine, Wis.
Greenfield Tap & Die Corp., Greenfield, Mass.
H. R. Krueger Co., Detroit
Lewis Fdry. & Mach. Div. of Blaw-Knox Co., Pittsburgh 30
Mattison Machine Works, Rockford, Ill.
Medart Co., St. Louis 18
Mercury Products Co., Cleveland 14
Mesta Machine Co., Pittsburgh 30
W. K. Millholland Machinery Co., Indianapolis
Norton Co., Worcester 6, Mass.
Pines Engineering Co., Aurora, Ill.
William Sellers & Co., Inc., Philadelphia 20
Snyder Tool & Eng. Co., Detroit 7
Yoder Co., Cleveland 2
Smalley General Co., Bay City, Mich.

Cutting-Off

Abrasive Cut-Off Machines

Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn.
Andrew Campbell Co., Div., American Chain & Cable Co., Inc., Bridgeport 2, Conn.
Catskill Metal Works, Inc., Catskill, N. Y.
Cincinnati Electrical Tool Co., Cincinnati
Delta Mfg. Co., Milwaukee 1, Wis.
A. P. DeSanno & Sons, Inc., Phoenixville, Pa.
Dewalt Products Corp., Lancaster, Pa.
Failor-Strafer Machinery Co., Jersey City, N. J.
Gray Foundry, Inc., Poultney, Vt.
Ralph Hochman & Co., Newark
A. Klinkelhofer, Inc., New York
Landis Machine Co., Waynesboro, Pa.
Minute-Man Machine Co., Cincinnati
Pines Engineering Co., Inc., Aurora, Ill.
Porter, McLeod Machine Tool Co., Inc., Hatfield, Mass.
Quijada Tool Co., Los Angeles
Robertson Mfg. Co., Trenton, N. J.
Stewart Machine Tool Co., Paterson, N. J.
Tabor Mfg. Co., Philadelphia
Walker-Turner Co., Inc., East Plainfield, N. J.

Cut-Off Machines (lathe type)

Aetna-Standard Engineering Co., Youngstown 1, Ohio
Bardons & Oliver, Inc., Cleveland
Brown & Sharpe Mfg. Co., Providence, R .I.
Consolidated Machine Tool Corp., Rochester 10, N. Y.
Etna Machine Co., Toledo, Ohio
Hasco Machinery Co., Newark
William Laidlaw, Inc., Belmont, N. Y.
Landis Machine Co., Waynesboro, Pa.
Modern Machine Tool Co., Jackson, Mich.
Murchey Machine & Tool Co., Detroit 26
Oster Mfg. Co., Cleveland 3
Peerless Machine Co., Racine, Wis.
Pines Engineering Co., Aurora, Ill.
Taylor-Wilson Mfg., Pittsburgh
Yoder Co., Cleveland 2

Flame Cutting

Oxyacetylene Cutting Equipment
(See Oxyacetylene Welding Equipment)

Saws

Saws, band

Armstrong-Blum Mfg. Co., Chicago 39
E. C. Atkins & Co., Indianapolis, Ind.
Boice-Crane Co., Toledo, Ohio
M. Brodie Co., Los Angeles
Carter Products Co., Grand Rapids, Mich.
Delta Mfg. Co., Milwaukee 1, Wis.
Henry Disston & Sons, Inc., Philadelphia 35
DoAll Co., Minneapolis, Minn.
Duro Metal Products Co., Chicago
G. W. Griffin Co., Franklin, N. H.
Jones Superior Machine Co., Chicago
Machine Tool Div., Kalamazoo Tank & Silo Co., Kalamazoo, Mich.
Moak Machine & Tool Co., Port Huron, Mich.
Oliver Machinery Co., Grand Rapids, Mich.
Simonds Saw & Steel Co., Boston 27
Spartan Saw Works, Inc., Springfield, Mass.
Tannewitz Works, Grand Rapids, Mich.
Universal Vise & Tool Co., Parma, Mich.
J. D. Wallace & Co., Chicago
Wells Mfg. Co., Three Rivers, Mich.

Saws, circular

E. C. Atkins & Co., Indianapolis, Ind.
Baush Machine Tool Co., Springfield, Mass.
Boice-Crane Co., Toledo, Ohio
Brown & Sharpe Mfg. Co., Providence, R. I.
Cochrane Bly Co., Rochester, N. Y.
Consolidated Mach. Tool Corp., Rochester, N. Y.
Delta Mfg. Co., Milwaukee, Wis.
DeWalt Products Corp., Lancaster, Pa.
Henry Disston & Sons, Inc., Philadelphia
Earle Gear & Machine Co., Philadelphia
Espen-Lucas Machine Works, Philadelphia
Etna Machine Co., Toledo, Ohio
Heller Machine Co., New York
Huther Bros. Saw & Mfg. Co., Rochester, N. Y.
Kane & Roach, Inc., Syracuse, N. Y.
A. Klineelhofer, Inc., New York
Morgan Construction Co., Worcester, Mass.
Motch & Merryweather Machinery Co., Cleveland
Porter-Cable Machine Co., Syracuse, N. Y.
Porter, McLeod Machine Tool Co., Hatfield, Mass.
United Engineering & Foundry Co., Pittsburgh
Yoder Co., Cleveland
Youngstown Foundry & Machine Co., Youngstown, Ohio

Saws, contour

Continental Machines Inc., Minneapolis 4, Minn.
DoAll Co., Minneapolis, Minn.
Grob Brothers, Grafton, Wis.
Universal Vise & Tool Co., Parma, Mich.

Saws, friction

Bethlehem Fdry. & Mach. Co., Bethlehem, Pa.
DoAll Co., Minneapolis, Minn.
Kling Bros. Engineering Works, Chicago
Morgan Engineering Co., Alliance, Ohio
Joseph T. Ryerson & Sons, Inc., Chicago
United Engineering & Foundry Co., Pittsburgh

Saws, power hack

Armstrong-Blum Mfg. Co., Chicago 39
E. C. Atkins & Co., Indianapolis, Ind.
Capewell Mfg. Co., Hartford, Conn.
Champion Blower & Forge Co., Lancaster, Pa.
Cochrane-Bly Co., Rochester, N. Y.
Covel Mfg. Co., Benton Harbor, Mich.
Henry Disston & Sons Inc., Philadelphia 35
Earle Gear & Machine Co., Philadelphia
G. W. Griffin Co., Franklin, N. H.
Heller Machine Co., New York
A. Klinkelhofer, Inc., New York
L-W Chuck Co., Toledo, Ohio
Marburg Brothers, Inc., New York
Miller-Knuth Co., Omaha, Neb.
Oster Mfg. Co., Cleveland
Peerless Machine Co., Racine, Wis.
Racine Tool & Mach. Co., Racine, Wis.
Royersford Foundry & Mach. Co., Royersford, Pa.
Joseph T. Ryerson, Inc., Chicago
Sales Service Machine Tool Co., St. Paul, Minn.
Simonds Saw & Steel Co., Boston 27
Sparton Saw Works, Inc., Springfield, Mass.
T & S Engineering Co., Pasadena, Cal.
Wells Mfg. Corp., Three Rivers, Mich.

Shears

Shears, bar, billet, bloom

Aetna-Standard Engineering Co., Youngstown, Ohio
Baldwin Southwark Div., Baldwin Locomotive Works, Eddystone, Pa.
E. W. Bliss Co., Brooklyn
Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.
Buffalo Forge Co., Buffalo, N. Y.
Cleveland Punch & Shear Works Co., Cleveland
Continental Foundry & Machine Co., East Chicago, Ind.
Hilyard Co., Norristown, Pa.
Hydropress, Inc., New York
Kane & Roach, Inc., Syracuse, N. Y.
Kling Bros. Engineering Works, Chicago
A. Klinkelhofer, Inc., New York
Lake Erie Engineering Corp., Buffalo, N. Y.
Lewis Foundry & Machine Div., Blaw-Knox Co., Pittsburgh
Loewy Eng'g. Co., Ltd., New York
Mackintosh-Hemphill Co., Pittsburgh
Mesta Machine Co., Pittsburgh
Morgan Construction Co., Worcester, Mass.
Morgan Engineering Co., Alliance, Ohio
Pawtucket Manufacturing Co., Pawtucket, R. I.
Joseph T. Ryerson & Sons, Inc., Chicago
Thomas Machine Mfg. Co., Pittsburgh
Toledo Machine & Tool Co., Toledo, Ohio
United Engineering & Foundry Co., Pittsburgh
R. D. Wood Co., Philadelphia
Youngstown Foundry & Machine Co., Youngstown, Ohio

Shears, bench

Beverly Shear Mfg. Co., Chicago
Bremil Mfg. Co., Erie, Pa.
Buffalo Forge Co., Buffalo, N. Y.
A. Klinkelhofer, Inc., New York
L. A. B. Corp., Summit, N. J.
Marshalltown Mfg. Co., Marshalltown, Iowa
McWilliams Mfg. Co., Inc., Providence, R. I.
Mohn Machine Co., Reading, Pa.
Niagara Machine & Tool Works, Buffalo, N. Y.
W. W. Oliver Mfg. Co., Buffalo, N. Y.
O'Neil-Irwin Mfg. Co., Minneapolis, Minn.
Peck, Stow & Wilcox Co., Southington, Conn.
Stanley Electric Tool Div., Stanley Works, New Britain, Conn.
U. S. Steel Supply Co., Chicago
De Witt C. Wagner, Cedar Rapids, Iowa
Whitney Metal Tool Co., Rockford, Ill.

Shears, beveling

Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.
Cleveland Punch & Shear Works Co., Cleveland
Hilyard Co., Norristown, Pa.
Quickwork Div., Whiting Corp., Harvey, Ill.
Thomas Machine Mfg. Co., Pittsburgh
Williams White & Co., Moline, Ill.

Shears, plate

Alliance Machine Co, Alliance, Ohio
Beatty Machine & Mfg. Co., Hammond, Ind.
Bertsch & Co., Cambridge City, Ind.
Blaw-Knox Div., Blaw-Knox Co., Pittsburgh
E. W. Bliss Co., Brooklyn
Buffalo Forge Co., Buffalo, N. Y.
Cincinnati Shaper Co., Cincinnati
Cleveland Crane & Engineering Co., Wickliffe, Ohio
Cleveland Punch & Shear Works Co., Cleveland
Consolidated Mach. Tool Corp., Rochester, N. Y.
Continental Fdry. & Mach. Co., East Chicago, Ind.
Failor-Strafer Machinery Co., Jersey City, N. J.
Hydropress, Inc., New York
Industrial Brownhoist Corp., Bay City, Mich.
Kane & Roach, Inc., Syracuse, N. Y.
Kling Bros. Engineering Works, Chicago
Lake Erie Engineering Corp., Buffalo, N. Y.
Lewis Foundry & Machine Div., Blaw-Knox Co., Pittsburgh
T. H. Lewthwaite Machine Co., New York
Loewy Eng'g. Co., Ltd., New York
Mesta Machine Co., Pittsburgh
Morgan Construction Co., Worcester, Mass.
Morgan Engineering Co., Alliance, Ohio
Niagara Machine & Tool Works, Buffalo, N. Y.
Joseph T. Ryerson & Sons, Inc., Chicago
Simmons Machine Tool Corp., Albany, N. Y.
Streine Tool & Mfg. Co., New Bremen, Ohio
Thomas Machine Mfg. Co., Pittsburgh
Toledo Machine & Tool Div., E. W. Bliss Co., Toledo, Ohio
United Engineering & Foundry Co., Pittsburgh
U. S. Steel Supply Co., Chicago
Western Iron & Foundry Co., Wichita, Kansas
Williams White & Co., Moline, Ill.
Quickwork Div., Whiting Corp., Harvey, Ill.
R. D. Wood Co., Philadelphia
Youngstown Foundry & Machine Co., Youngstown, Ohio

Shears, rotary

E. W. Bliss Co., Brooklyn
Brown & Sharpe Mfg. Co., Providence, R. I.
Frederick M. Conran Machine Co., Newark
Consolidated Machine Tool Corp., Rochester 10, N. Y.
L. M. Gilbert Co., Philadelphia
Hydropress, Inc., New York 22
Kane & Roach, Shonard & Holland, Syracuse, N. Y.
Kling Bros. Engineering Works, Chicago
Loewy Eng'g. Co., Ltd., New York
Loma Machine Mfg. Co., Inc., New York
McWilliams Mfg. Co., Inc., Providence, R. I.
Mesta Machine Co., Pittsburgh
Morgan Construction Co., Worcester, Mass.
Niagara Machine & Tool Works, Buffalo, N. Y.
Peck, Stow & Wilcox Co., Southington, Conn.
Pettingell Machine Co., Amesbury, Mass.
Quickwork Div., Whiting Corp., Harvey, Ill.
Joseph T. Ryerson & Sons, Inc., Chicago
Simonds Saw & Steel Co., Boston 27
Streine Tool & Mfg. Co., New Bremen, Ohio
Toledo Machine & Tool Co., Toledo, Ohio
United Engineering & Foundry Co., Pittsburgh
United States Steel Supply Co., Chicago
Wean Engineering Co., Inc., Warren, Ohio
Wichita Wire & Iron Co., Wichita Falls, Texas
Williams White & Co., Moline, Ill.
Wysong & Miles Co., Greensboro, N. C.
Yoder Co., Cleveland 2

Shears, squaring

Beatty Mach. & Mfg. Co., Hammond, Ind.
E. W. Bliss Co., Brooklyn
Buffalo Forge Co., Buffalo, N. Y.
Cincinnati Shaper Co., Cincinnati
Cleveland Crane & Engrg. Co., Wickliffe, Ohio
Cleveland Punch & Shear Works, Cleveland
Columbia Machine Tool Co., Hamilton, Ohio
Consolidated Machine Tool Corp., Rochester 10, N. Y.
Dodge Mfg. Corp., Mishawaka, Ind.
Edward J. Dreis Co., Ltd., San Francisco
Famco Machine Co., Racine, Wis.
Kent-Owens Machine Co., Toledo, Ohio
A. Klinkelhofer, Inc., New York
Mesta Machine Co., Pittsburgh
Mitts & Merrill, Saginaw, Mich.
Morgan Engineering Co., Alliance, Ohio
Niagara Machine & Tool Works, Buffalo, N. Y.
O'Neil-Irwin Mfg. Co., Minneapolis, Minn.
Peck, Stow & Wilcox Co., Southington, Conn.
Henry Pels & Co., New York
Royersford Foundry & Mach. Co., Royersford, Pa.
Joseph T. Ryerson & Sons, Inc., Chicago
Schatz Mfg. Co., Poughkeepsie, N. Y.
Thomas Machine Mfg. Co., Pittsburgh
Toledo Machine & Tool Co., Toledo, Ohio
United Engineering & Foundry Co., Pittsburgh
Whitney Metal Tool Co., Rockford, Ill.
Youngstown Foundry & Machine Co., Youngstown, Ohio

Heat Treating and Heating

Furnaces, laboratory and tool room

Ajax Electric Co., Inc., Philadelphia
Ajax Electrothermic Corp., Trenton 5, N. J.
American Gas Furnace Co., Elizabeth, N. J.
American Instrument Co., Silver Spring, Md.
Anthony Company, Long Island City, N. Y.
Baker & Co., Inc., Newark
Barkling Fuel Engineering Co., Chicago
Bellevue Industrial Furnace Co., Detroit
Bellis Heat Treating Branford, Conn.
Burrell Technical Supply Co., Pittsburgh
Campbell-Hausfeld Co., Harrison, Ohio
Central Scientific Co., Chicago
Cooley Electric Mfg. Corp., Indianapolis 7, Ind.
Continental Industrial Engineers, Chicago
W. H. Curtin & Co., Houston, Texas
Denver Fire Clay Co., Denver
Despatch Oven Co., Minneapolis, Minn.
Detroit Electric Furnace Div., Kuhlman Electric Co. Bay City, Mich.
Harry W. Dietert Co., Detroit 4
Ecco High Frequency Corp., North Bergen, N. J.
Eclipse Fuel Engineering Co., Rockford, Ill.
Eisler Engineering Co., Newark
Falcon Equipment Co., New Brighton, Pa.
John R. Gearhart Co., Oakland, Cal.
Claud S. Gordon Co., Chicago
Emil Grenier Co., New York
C. M. Hall Lamp Co., Detroit 7
Harper Electric Furnace Corp., Niagara Falls, N. Y.
Hauck Mfg. Co., Brooklyn
Hevi Duty Electric Co., Milwaukee 1, Wis.
Charles A. Hones, Inc., Baldwin, N. Y.
Hoskins Mfg. Co., Detroit
K. H. Huppert Co., Chicago
Industrial Heating Equipment Co., Detroit
Jelrus Co., New York
Johnson Gas Appliance Co., Cedar Rapids, Iowa
James H. Knapp Co., Los Angeles
Lansing Engineering Co., Lansing, Mich.
Arthur S. La Pine & Co., Chicago
Leeds & Northrup Co., Philadelphia 44
Lepel High Frequency Laboratories, New York 23
Lindberg Engineering Co., Chicago
Lithium Co., Newark
Lydon Bros., Jersey City, N. J.
E. Machlett & Son, New York
Mahr Mfg. Co., Minneapolis, Minn.
Naudain Mfg. Co., Baltimore
Palo-Meyers, Inc., New York
G. S. Peterson Co., Cleveland
Pittsburgh Electromelt Furnace Co., Pittsburgh
W. S. Rockwell Co., Fairfield, Conn.
R-S Products Corp., Philadelphia
Scientific Electric Div., S. Corrugated Quenched Gap Co., Garfield, N. J.
Sentry Co., Foxboro, Mass.
Stewart Furnace Div., Chicago Flexible Shaft Co., Chicago
Surface Combustion Corp., Toledo, Ohio
Tate-Jones Co., Inc., Leetsdale, Pa.
Thermo Electric Mfg. Co., Dubuque, Iowa
Thwing-Albert Instrument Co., Philadelphia
Harold E. Trent Co., Philadelphia
Vulcan Corp., Philadelphia
Westinghouse Electric Corp., E. Pittsburgh, Pa.

Furnaces, electric

Abbott Corp., Chicago
Acme Electric Heating Co., Boston
Acme Furnace Co., Chicago
Aeroil Products Co., West New York, N. J.
Ajax Electric Co., Inc., Philadelphia
Ajax Electrothermic Corp., Trenton, N. J.
American Bridge Co., Pittsburgh
American Car & Foundry Co., New York
American Electric Furnace Co., Boston
Associated Industrial Engineers, Inc., Philadelphia
Bellevue Industrial Furnace Co., Detroit
Bellis Heat Treating, Branford, Conn.
Burrell Technical Supply Co., Pittsburgh
Calorac Electric Corp., Hartford, Conn.
Case Hardening Service Co., Cleveland
Frank C. Cheston Co., New York
Continental Industrial Engineers, Inc., Chicago
Cooley Electric Mfg. Corp., Indianapolis 7, Ind.
Dempsey Industrial Furnace Corp., Springfield, Mass.
Despatch Oven Co., Minneapolis, Minn.
Detroit Electric Furnace Div., Kuhlman Electric Co., Bay City, Mich.
Drever Co., Philadelphia
Eisler Engineering Co., Newark
Electric Furnace Co., Salem, Ohio
Electric Heating Equipment Co., Philadelphia
Falcon Equipment Co., New Brighton, Pa.
Falls Electric Furnace Corp., Buffalo, N. Y.
Federal Electric Co., Inc., Chicago
Fisher Scientific Co., Pittsburgh
Claud S. Gordon Co., Chicago
John R. Gearhart Co., Oakland, Cal.
General Electric Co., Schenectady, N. Y.
George J. Hagan Co., Pittsburgh
Hanovia Chemical & Mfg. Co., Newark
Harper Electric Furnace Corp., Niagara Falls, N. Y.
C. I. Hayes, Inc., Providence, R. I.
Hevi Duty Electric Co., Milwaukee 1, Wis.
Holcroft & Co., Detroit
A. F. Holden Co., West Haven, Conn.
Hoskins Mfg. Co., Detroit
K. H. Huppert Co., Chicago
Charles F. Kenworthy, Inc., Waterbury, Conn.
James H. Knapp Co., Los Angeles
Lancaster Iron Works, Inc., Lancaster, Pa.
Leeds & Northrup Co., Philadelphia
Lepel High Frequency Laboratories, New York 23
Lindberg Engineering Co., Chicago
Lithium Co., Newark
Lydon Bros., Jersey City, N. J.
Mahr Mfg. Co., Minneapolis, Minn.
Miller-Robinson Co., Los Angeles
Morrison Engineering Corp., Cleveland
Pacific Scientific Co., Aeronautical Div., Los Angeles
G. S. Peterson Co., Cleveland
Pittsburgh Lectromelt Furnace Corp., Pittsburgh 30
Precision Scientific Co., Chicago
R-S Products Corp., Philadelphia
Radiant Combustion, Inc., Warren, Ohio
Reliance Steel Products Co., McKeesport, Pa.
W. S. Rockwell Co., Fairfield, Conn.
Salem Engineering Co., Salem, Ohio
Sargeant & Wilbur, Pawtucket, R. I.
Sentry Co., Foxboro, Mass.
Swindell-Dressler Corp., Pittsburgh
Tate-Jones & Co., Inc., Leetsdale, Pa.
Thermo Electric Mfg. Co., Dubuque, Iowa
Harold E. Trent Co., Philadelphia
Upton Electric Furnace Div., Detroit
Vulcan Corp., Philadelphia
Westinghouse Electric Corp., E. Pittsburgh, Pa.
Whiting Corp., Harvey, Ill.

Furnaces, fuel fired

Acme Furnace Co., Chicago
Aeroil Products Co., West New York, N. J.
American Electric Furnace Co., Boston
American Gas Furnace Co., Elizabeth, N. J.
Associated Industrial Engineer, Inc., Philadelphia
Bellevue Industrial Furnace Co., Detroit 7
Bellis Heat Treating, Branford, Conn.
Carl-Mayer Corp., Cleveland
Case Hardening Service Co., Cleveland
Continental Industrial Engineers, Inc., Chicago
Delaware Tool Steel Corp., Wilmington, Delaware
Dempsey Industrial Furnace Corp., Springfield, Mass.
Despatch Oven Co., Minneapolis, Minn.
Drever Co., Philadelphia
Eclipse Fuel Engineering Co., Rockford, Ill.
Electric Furnace Co., Salem, Ohio
Flinn & Dreffein Co., Chicago
Gas Machinery Co., Cleveland
John R. Gearhart Co., Oakland, Cal.
Claud S. Gordon Co., Chicago
George J. Hagan Co., Pittsburgh
Holcroft & Co., Detroit
A. F. Holden Co., West Haven, Conn.
Chas. A. Hones, Inc., Baldwin, N. Y.
Industrial Heating Equipment Co., Detroit
Industrial Oven Engineering Co., Cleveland 2
Johnson Gas Appliance Co., Cedar Rapids, Iowa
Johnston Mfg. Co., Minneapolis, Minn.
Charles F. Kenworthy, Inc., Waterbury, Conn.
S. P. Kinney Engineers, Inc., Pittsburgh
James H. Knapp Co., Los Angeles
Lansing Engineering Co., Lansing, Mich.
Lindberg Engineering Co., Chicago
Lithium Co., Newark
Loftus Engineering Corp., Pittsburgh
Mahr Mfg. Co., Minneapolis, Minn.
McCann-Harrison Div., Foundry Equipment Co., Cleveland
Morrison Engineering Corp., Cleveland
Morse Chain Co., Ithaca, N. Y.
Philadelphia Drying Machinery Co., Philadelphia
R-S Products Corp., Philadelphia
Radiant Combustion, Inc., Warren, Ohio
W. S. Rockwell Co., Fairfield, Conn.
Salem Engineering Co., Salem, Ohio
Sargeant & Wilbur, Pawtucket, R. I.
Selas Corp. of America, Philadelphia
Standard Fuel Engineering Co., Detroit
Stark Tool Co., Waltham, Mass.
Stewart Industrial Furnace Div., Chicago Flexible Shaft Co., Chicago
Strong, Carlisle & Hammond Co., Cleveland
Surface Combustion Corp., Toledo, Ohio
Swindell-Dressler Corp., Pittsburgh 30
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia
Wellman Engineering Co., Cleveland
Westinghouse Electric Corp., Pittsburgh
Lee Wilson Engineering Co., Cleveland

Furnaces, high speed steel hardening

Ajax Electric Co., Inc., Philadelphia
American Electric Furnace Co., Boston
American Gas Furnace Co., Elizabeth, N. J.
Bellevue Industrial Furnace Co., Detroit
Dempsey Industrial Furnace Corp., Springfield, Mass.
Falcon Equipment Co., New Brighton, Pa.
Harper Electric Furnace Corp., Niagara Falls, N. Y.
C. I. Hayes, Inc., Providence, R. I.
K. H. Huppert Co., Chicago
Johnson Gas Appliance Co., Cedar Rapids, Iowa
Lepel High Frequency Laboratories, New York
Naudain Mfg. Co., Baltimore
R-S Products Corp., Philadelphia
Stewart Furnace Div., Chicago Flexible Shaft Co., Chicago
Upton Electric Furnace Div., Detroit
Vulcan Corp., Philadelphia

Furnaces, lead bath

Acme Furnace Co., Chicago
Ajax Electric Co., Inc., Philadelphia
American Electric Furnace Co., Boston
American Gas Furnace Co., Elizabeth, N. J.
Associated Industrial Engineers, Inc., Philadelphia
Bellevue Industrial Furnace Co., Detroit
Bellis Heat Treating, Branford, Conn.
Continental Industrial Engineers, Inc., Chicago
Delaware Tool Steel Corp., East Wilmington, Del.
Dempsey Industrial Furnace Corp., Springfield, Mass.
Eclipse Fuel Engineering Co., Rockford, Ill.
John R. Gearhart Co., Oakland, Cal.
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago
Johnson Gas Appliance Co., Cedar Rapids, Iowa
Johnston Mfg. Co., Minneapolis, Minn.
James H. Knapp Co., Los Angeles
R-S Products Corp., Philadelphia
W. S. Rockwell Co., Fairfield, Conn.
Sentry Co., Foxboro, Mass.
Standard Fuel Engineering Co., Detroit
Stewart Furnace Div., Chicago Flexible Shaft Co., Chicago
Surface Combustion Corp., Toledo, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.
Harold E. Trent Co., Philadelphia
Vulcan Corp., Philadelphia
Westinghouse Electric Corp., E. Pittsburgh, Pa.

Furnaces, melting (see under Casting)

Furnaces, oil bath

Acme Furnace Co., Chicago
Aeroil Products Co., West New York, N. J.
Ajax Electric Co., Inc., Philadelphia

Processing Equipment for Peacetime Production

American Electric Furnace Co., Boston
American Gas Furnace Co., Elizabeth, N. J.
Associated Industrial Engineers, Inc., Philadelphia
Bellevue Industrial Furnace Co., Detroit
Bellis Heat Treating, Branford, Conn.
Continental Industrial Engineers, Inc., Chicago
Dempsey Industrial Furnace Corp., Springfield, Mass.
Despatch Oven Co., Minneapolis, Minn.
Eclipse Fuel Engineering Co., Rockford, Ill.
Falcon Equipment Co., New Brighton, Pa.
John R. Gearhart Co., Oakland, Cal.
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago
Johnson Gas Appliance Co., Cedar Rapids, Iowa
Johnston Mfg. Co., Minneapolis, Minn.
James H. Knapp Co., Los Angeles
Lindberg Engineering Co., Chicago
Morrison Engineering Corp., Cleveland
R-S Products Corp., Philadelphia
W. S. Rockwell Co., Fairfield, Conn.
Standard Fuel Engineering Co., Detroit
Stewart Furnace Div., Chicago Flexible Shaft Co., Chicago
Surface Combustion Corp., Toledo, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.
Harold E. Trent Co., Philadelphia
Vulcan Corp., Philadelphia
Westinghouse Electric Corp., E. Pittsburgh, Pa.

Furnaces, reheating and forging

Acme Furnace Co., Chicago
Ajax Electric Co., Philadelphia 23
Ajax Electrothermic Corp., Trenton 5, N. J.
American Electric Furnace Co., Boston
American Gas Furnace Co., Elizabeth, N. J.
Amsler-Morton Co., Pittsburgh 22
Associated Industrial Engineers, Inc., Philadelphia
Barkling Fuel Engineering Co., Chicago
Bellis Heat Treating, Branford, Conn.
Frank C. Cheston Co., New York
Continental Industrial Engineers, Inc., Chicago
Dempsey Industrial Furnace Corp., Springfield, Mass.
Despatch Oven Co., Minneapolis, Minn.
Drever Co., Philadelphia
Eclipse Fuel Engineering Co., Rockford, Ill.
Electric Furnace Co., Salem, Ohio
Flinn & Dreffein Co., Chicago
Gas Machinery Co., Cleveland
John R. Gearhart Co., Oakland, Cal.
Claud S. Gordon Co., Chicago
George J. Hagan Co., Pittsburgh
Holcroft & Co., Detroit
A. F. Holden Co., New Haven 8, Conn.
K. H. Huppert Co., Chicago
Industrial Heating Equipment Co., Detroit
Industrial Oven Engineering Co., Cleveland 2
Johnson Gas Appliance Co., Cedar Rapids, Iowa
Johnston Mfg. Co., Minneapolis, Minn.
Charles F. Kenworthy, Waterbury, Conn.
James H. Knapp Co., Los Angeles
Lansing Engineering Co., Lansing, Mich.
Lepel High Frequency Laboratories, New York 23
Lindberg Engineering Co., Chicago
Lithium Co., Newark
Loftus Engineering Corp., Pittsburgh
McCann-Harrison Div., Foundry Equipment Co., Cleveland
Morgan Construction Co., Worcester, Mass.
Morrison Engineering Corp., Cleveland
Pennsylvania Industrial Engineers, Pittsburgh 12
G. S. Peterson Co., Cleveland
R-S Products Corp., Philadelphia
W. S. Rockwell Co., Fairfield, Conn.
Salem Engineering Co., Salem, Ohio
Standard Fuel Engineering Co., Detroit
Stewart Furnace Div., Chicago Flexible Shaft Co., Chicago
Surface Combustion Corp., Toledo, Ohio
Swindell-Dressler Corp., Pittsburgh 30
Tate-Jones & Co., Inc., Leetsdale, Pa.
Harold E. Trent Co., Philadelphia
Whiting Corp., Harvey, Ill.
Lee Wilson Engineering Co., Inc., Cleveland 16

Furnaces, salt bath, electric

Acme Furnace Co., Chicago
Ajax Electric Co., Inc., Philadelphia
American Electric Furnace Co., Boston
Bellis Heat Treating, Branford, Conn.
Continental Industrial Engineers, Inc., Chicago
Dempsey Industrial Furnace Corp., Springfield, Mass.
Electric Furnace Co., Salem, Ohio
John R. Gearhart Co., Oakland, Cal.
General Electric Co., Schenectady, N. Y.
Claud S. Gordon, Chicago
A. F. Holden Co., West Haven, Conn.
R-S Products Corp., Philadelphia
W. S. Rockwell Co., Fairfield, Conn.
Sentry Co., Foxboro, Mass.
Surface Combustion Corp., Toledo, Ohio
Harold E. Trent Co., Philadelphia
Upton Electric Furnace Div., Detroit
Vulcan Corp., Philadelphia
Westinghouse Electric Corp., E. Pittsburgh, Pa.

Furnaces, salt bath, fuel fired

Acme Furnace Co., Chicago
American Gas Furnace Co., Elizabeth, N. J.
Bellis Heat Treating, Branford, Conn.
Continental Industrial Engineers, Inc., Chicago
Dempsey Industrial Furnace Corp., Springfield, Mass.
Eclipse Fuel Engineering Co., Rockford, Ill.
Electric Furnace Co., Salem, Ohio
John R. Gearhart Co., Oakland, Cal.
Claud S. Gordon Co., Chicago
Johnson Gas Appliance Co., Cedar Rapids, Iowa
Johnston Mfg. Co., Minneapolis, Minn.
James H. Knapp Co., Los Angeles
R-S Products Corp., Philadelphia
W. S. Rockwell Co., Fairfield, Conn.
Standard Fuel Engineering Co., Detroit
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia
Westinghouse Electric Corp., E. Pittsburgh, Pa.

Furnaces, special purpose

Ajax Electric Co., Inc., Philadelphia
Ajax Electrothermic Corp., Trenton, N. J.
American Electric Furnace Co., Boston
American Gas Furnace Co., Elizabeth, N. J.
Burrell Technical Supply Co., Pittsburgh
Campbell-Hausfeld Co., Harrison, Ohio
Campion Laboratories, Detroit
Dempsey Industrial Furnace Corp., Springfield, Mass.
Denver Fire Clay Co., Denver
Despatch Oven Co., Minneapolis, Minn.
Electric Furnace Co., Salem, Ohio
Falcon Equipment Co., New Brighton, Pa.
Ferro Enamel Corp., Cleveland
Harper Electric Furnace Corp., Niagara Falls, N. Y.
A. F. Holden Co., New Haven, Conn.
Johnson Gas Appl. Co., Cedar Rapids, Iowa
James H. Knapp Co., Los Angeles
Lancaster Iron Works, Inc., Lancaster, Pa.
Lithium Company, Newark
Loftus Engineering Corp., Pittsburgh
Naudain Mfg. Co., Baltimore
G. S. Peterson Co., Cleveland
W. S. Rockwell Co., Fairfield, Conn.
R-S Products Corp., Philadelphia
Salem Engineering Co., Salem, Ohio
Stewart Furnace Div., Chicago Flexible Shaft Co., Chicago
Tate-Jones Co., Inc., Leetsdale, Pa.
Upton Electric Furnace Div., Detroit
Welding Engineers, Inc., Norristown, Pa.

Furnaces and Equipment, induction and dielectric heating

Ajax Electrothermic Corp., Trenton, N. J.
Allied Radio Corp., Chicago
Allis Chalmers Mfg. Co., Milwaukee, Wis.
Budd Wheel Co., Induction Heating Div., Detroit
Campbell Electric Co., Lynn, Mass.
Frank C. Chesterton Co., New York
Ecco High Frequency Corp., North Bergen, N. J.
Eisler Engineering Co., Newark
Electric Furnace Co., Salem, Ohio
Federal Electric Co., Inc., Chicago
Federal Telephone & Radio Corp., New York
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago
Induction Heating Corp., New York
Inducto Machine Co., Detroit
Lepel High Frequency Laboratories, New York 23
Ohio Crankshaft Co., Cleveland 1
R C A Victor Div., Camden, N. J.
R-S Products Corp., Philadelphia
Scientific Electric Div., S. Corrugated Quenched Gap Co., Garfield, N. J.
Van Norman Co., Springfield, Mass.
Victor Equipment Co., San Francisco
Westinghouse Electric Corp., E. Pittsburgh, Pa.

Furnaces and Equipment, resistance heating

Cutler-Hammer, Inc., Milwaukee, Wis.
Electric Heating Equipment Co., Philadelphia
Federal Mach. & Welder Co., Warren, Ohio
H & A Mfg. Co., Inc., Buffalo, N. Y.
Industrial Engineering Equipment Co., St. Louis
Industrial Heater Co., New York
Square D Co., Milwaukee, Wis.
Edwin L. Wiegand Co., Pittsburgh

Furnaces and Ovens, low temperature

Acme Furnace Co., Chicago
Ajax Electric Co., Inc., Philadelphia
American Machine & Foundry Co., Oven Division, New Haven, Conn.
Associated Industrial Engineers, Inc., Philadelphia
G. S. Blodgett Co., Burlington, Vt.
Charles T. Brandt, Inc., Baltimore 30
Burdett Mfg. Co., Chicago
Carl-Mayer Corp., Cleveland
Cleveland Blow Pipe & Mfg. Co., Cleveland
Despatch Oven Co., Minneapolis, Minn.
Drying Systems, Inc., Chicago
Electric Furnace Co., Salem, Ohio
Electric Heating Equipment Co., Philadelphia
Fostoria Pressed Steel Corp., Fostoria, Ohio
Gehnrich & Gehnrich, Inc., Woodside, L. I., N. Y.
Gehnrich Oven Div., W. S. Rockwell Co., Fairfield, Conn.
George J. Hagan Co., Pittsburgh 3
C. M. Hall Lamp Co., Hancock, Detroit 7
Holcroft & Company, Detroit
K. H. Huppert Co., Chicago
Industrial Oven Eng. Co., Cleveland 2
Lanlay Co., Cleveland
Paul Maehler Co., Chicago 12
R. C. Mahon Co., Detroit 11
McCann Furnace Co., Cleveland
Morrison Engineering Corp., Cleveland
Proctor & Schwartz, Philadelphia
R C A Victor Division, Camden, N. J.
R-S Products Corp., Philadelphia
W. S. Rockwell Co., Fairfield, Conn.
Rolnick Testing & Mfg. Co., Philadelphia
Salem Engineering Co., Salem, Ohio
J. J. Siefen Co., Detroit 9
Steiner-Ives Company, Newark
Swartwout Oven Div., Foundry Equipment Co., Cleveland
Tate-Jones & Co. Inc., Leetsdale, Pa.
Harold E. Trent Co., Philadelphia
Wagner Litho Machinery Co., Hoboken, N. J.
Welding Engineers, Inc., Morristown, Pa.
Whiting Corporation, Harvey, Ill.
Young Bros. Co., Detroit

Furnace Controls (see under Process Control and Instrumentation)

Cold Treatment Equipment

American Coils Co., Newark
Audiffren Refrigerating Machine Co., New York
Bowser, Inc., Terryville, Conn.
Deepfreeze Div., Motor Products Corp., North Chicago, Ill.
General Electric Co., Bloomfield, N. J.
Jewett Refrigerator Co., Buffalo, N. Y.
Kold-Hold Mfg. Co., Lansing 4, Michigan

Flame Hardening Equipment

Air Reduction Sales Co., New York
American Welding & Mfg. Co., Warren, Ohio
Cullen-Friestedt Co., Chicago
Farrel-Birmingham Co., Inc., Ansonia, Conn.
Linde Air Products Co., New York 17
Liquid Carbonic Corp., Chicago
Motor Products Corp., Deep Freeze Div., N. Chicago, Ill.
National Cylinder Gas Co., Chicago
Victor Equipment Co., San Francisco 7

Quenching Systems and Equipment

Ajax Electric Co., Inc., Philadelphia
American Gas Furnace Co., Elizabeth, N. J.
Associated Industrial Engineers, Inc., Philadelphia
Bell & Gossett Co., Morton Grove, Ill.
Bellis Heat Treating, Branford, Conn.
G. S. Blakeslee & Co., Chicago
Case Hardening Service Co., Cleveland
Continental Industrial Engineers, Inc., Chicago
Dempsey Industrial Furnace Corp., Springfield, Mass.
Drever Co., Philadelphia
Electric Furnace Co., Salem, Ohio
Claud S. Gordon Co., Chicago
Hannifin Mfg. Co., Chicago
A. F. Holden Co., West Haven, Conn.
Howard Engineering & Mfg. Co., Cincinnati
Induction Heating Corp., New York
Johnston Mfg. Co., Minneapolis, Minn.
James H. Knapp Co., Los Angeles
Lindberg Engineering Co., Chicago
Loftus Engineering Corp., Pittsburgh
Metalwash Machinery Co., Irvington, N. J.
G. Peterson & Co., Cleveland
W. S. Rockwell Co., Fairfield, Conn.
Salem Engineering Co., Salem, Ohio
Spray Engineering Co., Somerville, Mass.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Urschel Engineering Co., Bowling Green, Ohio
Vulcan Corp., Philadelphia
Corundite Refractories, Inc., Massillon, Ohio

Soaking Pits

Amsler-Morton Co., Pittsburgh 22
Associated Industrial Engineers, Inc., Philadelphia
Blaw-Knox Div. of Blaw-Knox Co., Blawnox, Pa.
Continental Industrial Engineers, Inc., Chicago
Electric Furnace Co., Salem, Ohio
Flinn & Dreffein Co., Chicago
Johnston Mfg. Co., Minneapolis, Minn.
Loftus Engineering Corp., Pittsburgh
Salem Engineering Co., Salem, Ohio
Surface Combustion Corp., Toledo, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia
Wellman Engineering Co., Cleveland

Welding and Joining

Arc Welding

Atomic Hydrogen Welding Machines

Air Reduction Sales Co., New York
General Electric Co., Schenectady, N. Y.
Universal Power Corp., Cleveland

Electric Arc Welding Machines

Air Reduction Sales Co., New York
Allied Weld-Craft, Inc., Indianapolis, Ind.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Electric Fusion Corp., New Haven, Conn.
Anaconda Wire & Cable Co., New York 4
Bear Mfg. Co., Rock Island, Ill.
Borm Manufacturing Co., Elgin, Ill.
Champion Rivet Co., Cleveland
Comet Products Co., Chappaqua, N. Y.
Commonwealth Mfg. Corp., Cincinnati
Cutler-Hammer, Inc., Milwaukee 1, Wis.
Eastern Welding Equipment Co., New York
Eisler Engineering Co., Newark
Electric Arc, Inc., Newark
Electric Controller & Mfg. Co., Cleveland 4
Ergolyte Mfg. Co., Philadelphia
Federal Machine & Welder Co., Warren, Ohio
General Electric Co., Schenectady, N. Y.
Giant Grip Mfg. Co., Oshkosh, Wis.
Glenn-Roberts Co., Oakland, Cal.
Good-All Mfg. Co., Ogallala, Neb.
A. C. Greyhound Arc Welder Corp., Brooklyn
Hampton Electric Mfg. Co., Pittsburgh
Harnischfeger Corp., Milwaukee 14, Wis.
Hercules Electric & Mfg. Co., Inc., Brooklyn
Hobart Brothers Co., Troy, Ohio
Larkin Lectro Products Co., New York
K. O. Lee Co., Aberdeen, S. D.
Lewis & Erickson, Rockford, Ill.
Lincoln Electric Co., Cleveland
P. R. Mallory & Co., Inc., Indianapolis 6, Ind.
Marquette Mfg. Co., Inc., Minneapolis, Minn.
McKay Co., York, Pa.
Mid-States Equipment Co., Chicago 16
Miller Electric Manufacturing Co., Richmond, Ind.
National Electric Welding Mach. Co., Bay City, Mich.
Nelson Specialty Welding Equipt. Co., San Leandro, Cal.
O'Brien Machinery Co., Philadelphia
Ohio Brass Co., Mansfield, Ohio
Owen-Dyneto Corp., Syracuse, N. Y.
Owen Electric Mfg. Co., Fayetteville, N. C.
Progressive Welder Co., Detroit 12
Roth Welding Engrg. Co., Detroit
F. W. Shrader Co., Culver City, Cal.
Sight Feed Generator Co., Richmond, Ind.
A. O. Smith Corp., Milwaukee, Wis.
Smith Welding Equipment Corp., Minneapolis, Minn.
Square D Co., Milwaukee 12, Wis.
Stackpole Carbon Co., St. Marys, Pa.
Taylor-Winfield Co., Warren, Ohio
Trindl Products Ltd., Chicago
Turco Products, Inc., Los Angeles 54
Una Welding Inc., Cleveland
United States Steel Supply Co., Chicago 90
Universal Power Corp., Cleveland
Victor Equipment Co., San Francisco 7
Wahlert Products Corp., Brooklyn 1
Westinghouse Electric Corp., E. Pittsburgh, Pa.
Wilson Welder & Metals Co., Inc., New York

Gas-Shielded Arc Welding Machines

Air Reduction Sales Co., New York
Linde Air Products Co., New York
Westinghouse Electric Corp., E. Pittsburgh, Pa.

Submerged Arc Welding Machines

Linde Air Products Co., New York

Brazing

Brazing Machines

Ajax Electric Co., Inc., Philadelphia
Ajax Electrothermic Corp., Trenton 5, N. J.
American Electric Fusion Corp., Chicago
American Gas Furnace Co., Elizabeth, N. J.
Otto Bernz Co., Rochester, N. Y.
Borm Manufacturing Co., Elgin, Ill.
Frank C. Cheston Co., New York
Eisler Engineering Co., Newark
Ergolyte Mfg. Co., Philadelphia
Federal Telephone & Radio Corp., New York
General Electric Co., Schenectady, N. Y.
Harris Calorific Co., Cleveland
C. I. Hayes, Inc., Providence, R. I.
Ideal Commutator Dresser Co., Sycamore, Ill.
Induction Heating Corp., New York
Johnson Gas Appliance Co., Cedar Rapids, Iowa
Lepel High Frequency Laboratories, New York 23
Ohio Crankshaft Co., Cleveland 1
Stackpole Carbon Co., St. Marys, Pa.
Tolman Mfg. Co., Boston, Mass.
Harold E. Trent Co., Philadelphia
Universal Power Corp., Cleveland
Westinghouse Electric Corp., E. Pittsburgh, Pa.

Brazing Furnaces (see under Heat Treating and Heating for specific types)

Fastening and Riveting

Fastening and Riveting Machines

Aircraft Rivet Corp., Waupun, Wis.
Ajax Electric Co., Inc., Philadelphia 23
Ajax Electrothermic Corp., Trenton 5, N. J.
Chambersburg Engineering Co., Chambersburg, Pa.
Frank C. Cheston Co., New York
Chicago Rivet & Machine Co., Bellwood, Ill.
Cleveland Pneumatic Tool Co., Cleveland 5
General Engineering Co., Buffalo, N. Y.
General Riveters, Inc., Buffalo, N. Y.
Hanna Engineering Works, Chicago 22
Hannifin Mfg. Co., Chicago 24
High Speed Hammer Co., Inc., Rochester, N. Y.
Independent Pneumatic Tool Co., Chicago 6
Ingersoll-Rand Co., New York 4
Lepel High Frequency Laboratories, New York 23
Milford Rivet & Machine Co., Milford, Conn.
National Rivet & Mfg. Co., Waupun, Wis.
Salem Engineering Co., Salem, Ohio
F. W. Shrader Co., Culver City, Cal.
Studebaker Machine Co., Maywood, Ill.
Surface Combustion Div. of General Properties Co. Inc., Toledo 1, Ohio
Tate-Jones & Co. Inc., Leetsdale, Pa.
Tomkins-Johnson Co., Jackson, Mich.
H. P. Townsend Mfg. Co., Hartford, Conn.
Tubular Rivet and Stud Co., Wollaston, Mass.
R. D. Wood Co., Philadelphia

Oxyacetylene Welding

Oxyacetylene Welding Equipment

Air Reduction, New York 17
Bastian-Blessing Co., Chicago
Black Manufacturing Co., Baltimore, Md.
Burdett Mfg. Co., Chicago
Chicago Tool & Engineering Co., Chicago
Dockson Corp., Detroit
Harris Calorific Co., Cleveland
W. F. Hebard & Co., Chicago
Higgins Industries, Inc., New Orleans, La.
Imperial Brass Mfg. Co., Chicago
K-G Welding & Cutting Co., Inc., New York
Linde Air Products Co., New York 17
Liquid Carbonic Corp., Wall Chemicals Div., Chicago
Mid-States Equipment Co., Chicago 16
Mineweld Co., Indianapolis, Ind.
Morey Flux and Chemical Co., Wilmington, Del.
Multiweld Co., Indianapolis, Ind.
National Welding Equipment Co., San Francisco
Oakite Products, Inc., New York 6
Smith Welding Equipment Corp., Minneapolis, Minn.
Torchweld Equipment Div., Chicago
Turco Products, Inc., Los Angeles 54
United Tool & Die Co., Inc., Hartford, Conn.
Victor Equipment Co., San Francisco 7
Wahlert Products Corp., Brooklyn 1
Welders Supply & Mfg. Co., Cincinnati
Welding Service Sales, Inc., San Francisco
Weldit Acetylene Co., Detroit

Resistance Welding

Flash Welding Machines

Acme Electric Welder Co., Los Angeles
Federal Mach. & Welder Co., Warren, Ohio
Martin Electric Co., Detroit
Mesta Machine Co., Pittsburgh
National Electric Welding Machines Co., Bay City, Mich.
Ohio Machine Tool Co., Kenton, Ohio
Pier Equipment Mfg. Co., Benton Harbor, Mich.
Progressive Welder Co., Detroit
Sciaky Bros., Chicago
Swift Electric Welder Co., Detroit
Taylor Hall Welding Corp., Worcester, Mass.
Taylor-Winfield Corp., Warren, Ohio
Thomson-Gibb Electric Welding Co., Lynn, Mass.
Weldex, Inc., Detroit
Welding Machines Mfg. Co., Detroit
Westinghouse Electric Corp., E. Pittsburgh, Pa.

Seam Welding Machines

Acme Electric Welder Co., Los Angeles
Agnew Electric Co., Milford, Mich.
American Electric Fusion Corp., Chicago
Electric Arc, Inc., Newark
Federal Machine & Welder Co., Warren, Ohio
Hampton Electric Mfg. Co., New Kensington, Pa.
Larkin Lectro Products Co., New York
Martin Electric Co., Detroit
National Electric Welding Machines Co., Bay City, Mich.
Pier Equipment Mfg. Co., Benton Harbor, Mich.
Penn Tool & Machine Co., Danville, Ill.
Progressive Welder Co., Detroit
Sciaky Bros., Chicago
Swift Electric Welder Co., Detroit
Taylor-Winfield Corp., Warren, Ohio

Thomson-Gibb Electric Welding Co., Lynn, Mass.
Victor Equipment Co., San Francisco 7
Welding Machines Mfg. Co., Detroit
Westinghouse Electric Corp., E. Pittsburgh, Pa.
Yoder Co., Cleveland 2

Spot Welding Machines

Acme Electric Welder Co., Los Angeles
Agnew Electric Co., Milford, Mich.
American Electric Fusion Corp., Chicago
American Electrical Sales Co., Inc., New York
Callite Tungsten Corp., Union City, N. J.
Delta Equipment Co., Warren, Ohio
Eisler Engineering Co., Newark
Electric Arc, Inc., Newark
Engineering Co., Newark
Expert Welding Machine Co., Detroit
Federal Machine & Welder Co., Warren, Ohio
Hasco Machinery Co., Newark
Hercules Electric & Mfg. Co., Inc., Brooklyn
Interstate Machinery Co., Inc., Chicago
Kahle Engineering Co., North Bergen, N. J.
Larkin Lectro Products Co., New York
Lewis & Erickson, Rockford, Ill.
Martin Electric Co., Detroit
Metallizing Co. of America, Chicago
Micro Products Co., Chicago
National Electric Welding Machines Co., Bay City, Mich.
O'Brien Machinery Co., Philadelphia
Pier Equipment Mfg. Co., Benton Harbor, Mich.
Progressive Welder Co., Detroit
Rex Welder & Engineering Co., Kansas City, Mo.
Sciaky Bros., Chicago
Swift Electric Welder Co., Detroit
Taylor-Winfield Corp., Warren, Ohio
Thomson-Gibb Electric Welding Co., Lynn, Mass.
Universal Power Corp., Cleveland
Universal Welder Corp., Cleveland
Victor Equipment Co., San Francisco 7
Weldex, Inc., Detroit
Welding Machines Mfg. Co., Detroit
Westinghouse Electric Corp., E. Pittsburgh, Pa.

Upset-Butt Welding Machines

Acme Electric Welder Co., Los Angeles
Agnew Electric Co., Milford, Mich.
American Electric Fusion Corp., Chicago
Eisler Engineering Co., Newark
Electric Arc, Inc., Newark
Engineering Co., Newark
Federal Machine & Welder Co., Warren, Ohio
Kahle Engineering Co., North Bergen, N. J.
William Laidlaw, Inc., Belmont, N. Y.
Larkin Lectro Products Co., New York
Martin Electric Co., Detroit
Micro Products Co., Chicago
National Electric Welding Machines Co., Bay City, Mich.
Progressive Welder Co., Detroit
Rex Welder & Engineering Co., Kansas City, Mo.
Sciaky Bros., Chicago
Railway Track Work Co., Philadelphia
Swift Electric Welder Co., Detroit
Taylor-Winfield Corp., Warren, Ohio
Thomson-Gibb Electric Welding Co., Lynn, Mass.
Weldex, Inc., Detroit
Welding Machinery Mfg. Co., Detroit
Westinghouse Electric Corp., E. Pittsburgh, Pa.

Thermit Welding

Thermit Welding Equipment

Metal & Thermit Corp., New York 5

Cleaning and Pickling

Acid Pickling Equipment

Aetna-Standard Engineering Co., Youngstown 1, Ohio
Alvey-Ferguson Co., Cincinnati 9
G. S. Blakeslee & Co., Chicago
Blaw-Knox Div., Blaw-Knox Co., Pittsburgh
Broden Construction Co., Cleveland
Buffalo Wire Works Co., Buffalo 2, N. Y.
Erie Foundry Co., Erie, Pa.
Goodman Mfg. Co., Chicago
Amos H. Hall & Sons, Philadelphia
Hanson-Van Winkle-Munning Co., Matawan, N. J.
Hauser-Stander Tank Co., Cincinnati
Haveg Corp., Newark
Heil Engineering Co., Cleveland
Howard Engineering & Mfg. Co., Cincinnati
International Nickel Co., New York 5
Lewis Foundry & Machine Div. of Blaw-Knox Co., Pittsburgh 30
Meaker Co., Chicago 50
Mesta Machine Co., Pittsburgh 30
Metalwash Machinery Co., Irvington, N. J.
National Carbon Co., New York 17
N. Ransohoff Inc., Cincinnati 16
Salem Engineering Co., Salem, Ohio
Frederic B. Stevens, Inc., Detroit
U. S. Galvanizing & Plating Equipment Corp., Brooklyn
Wean Engineering Co., Warren, Ohio
Wheeling Bronze Casting Co., Wheeling, W. Va.
Youngstown Foundry & Machine Co., Youngstown, Ohio
Youngstown Welding & Engineering Co., Youngstown, Ohio

Alkaline and Solvent Cleaning Equipment

Alvey-Ferguson Co., Cincinnati
Circo Products Co., Cleveland
Detrex Corp., Detroit
Hauser-Stander Tank Co., Cincinnati
Howard Engineering & Mfg. Co., Cincinnati
L & R Manufacturing Co., Arlington, N. J.
Magnus Chemical Co., Inc., Garwood, N. J.
Metalwash Machinery Co., Irvington, N. J.
N. Ransohoff, Inc., Cincinnati 16
U. S. Galvanizing & Plating Equipment Corp., Brooklyn

Blast Cleaning Equipment

American Foundry Equipment Co., Mishawaka, Ind.
Dreisbach Engineering Corp., Yonkers, N. Y.
Hydro-Blast Corp., Chicago
I. O. Koven, Jersey City, N. J.
Leiman Bros., Inc., Newark
Macleod Co., Cincinnati
Mott Sand Blast Manufacturing, Chicago
Pangborn Corp., Hagerstown, Md.
Parsons Engineering Corp., Cleveland
Peoria Sand Blast Mfg. Co., Peoria, Ill.
Reliable Sand Blast Mfg. Co., Chicago
W. W. Sly Manufacturing Co., Cleveland
George M. Stowe, Jr., Buffalo, N. Y.
Vapor Blast Mfg. Co., Milwaukee, Wis.

Descaling Equipment and Processes

Ajax Electric Co, Inc., Philadelphia 23
American Chemical Paint Co., Ambler, Pa.
American Foundry Equipment Co., Mishawaka, Ind.
Bullard Co., Bridgeport, Conn.
Crown Rheostal & Supply Co., Chicago
Hanson-Van Winkle-Munning Co, Matawan, N. J.
Heil Engineering Co., Cleveland
A. F. Holden Co., New Haven 8, Conn.
Kelite Products Inc., Los Angeles 1
Linde Air Products Co., New York 17
Mitchell Engineering Co., Springfield, Ohio
Frederic B. Stevens, Inc., Detroit
United Engineering & Foundry Co., Pittsburgh
Youngstown Welding & Engineering Co., Youngstown, Ohio

Tumbling, Rolling, Burnishing Equipment

Abbott Ball Co., Hartford, Conn.
Baird Machine Co., Stratford, Conn.
L. P. Brown Machine & Tool Co., Attleboro, Mass.
Chicago Boiler Co., Chicago
Crown Rheostal & Supply Co., Chicago
Gleason Wks., Rochester, N. Y.
Hanson-Van Winkle-Munning Co., Matawan, N. J.
Hole Engineering Service, Detroit
J. Holland & Sons, Inc., Brooklyn
Howard Engineering & Mfg. Co., Cincinnati
Lasalco, Inc., St. Louis
Chas. F. L'Homedieu & Sons Co., Chicago
Lupomatic Tumbling Machine Co., New York
J. C. Miller Co., Grand Rapids, Mich.
N. Ransohoff, Inc., Cincinnati 16
W. W. Sly Manufacturing Co., Cleveland
Frederic B. Stevens, Inc., Detroit
Sturgis Products Co., Sturgis, Mich.
Whiting Corp., Harvey, Ill.

Vapor Degreasing Equipment

Alvey-Ferguson Co., Cincinnati
American Foundry Equipment Co., Mishawaka, Ind.
G. S. Blakeslee & Co., Cicero, Ill.
Circo Products Co., Cleveland
Crown Rheostal & Supply Co., Chicago
Detrex Corp., Detroit
Detroit Sheet Metal Works, Detroit
Drill Mfg. Co., Indianapolis, Ind.
Drying Systems, Inc., Chicago
Alex C. Fergusson Co., Philadelphia
Gray-Mills Co., Evanston, Ill.
Hauser-Stander Tank Co., Cincinnati
Howard Engineering & Mfg. Co., Cincinnati
Hydra Lectric Products Co., Indianapolis, Ind.
Industrial Washing Machine Corp., New Brunswick, N. J.
International Conveyor & Washer Corp., Detroit
L & R Mfg. Co., Arlington, N. J.
Magnus Chemical Co., Inc., Garwood, N. J.
Metalwash Machinery Co., Irvington, N. J.
Midwestern Sales, Inc., New York
Pacific Fabricating Co., Huntington Park, Cal.
Phillips Manufacturing Co., Chicago
Practical Products Co., Minneapolis, Minn.
N. Ransohoff, Inc., New York
Schmieg Industries, Detroit
Ernest Scott & Co., Fall River, Mass.
Solventol Chemical Products, Inc., Detroit
Tivit Products Co., Torrance, Cal.

Finishing and Coating

Electroplating Equipment

Alsop Engineering Corp., Milldale, Conn.
Belke Mfg. Co., Chicago
Benwood Linze Co., St. Louis
Charles T. Brandt Inc., Baltimore 30
Chicago Wheel & Mfg. Co., Chicago 7
Crown Rheostat & Supply Co., Chicago
Federal Telephone & Radio Corp., New York
W. Green Electric Co., Inc., New York
Amos H. Hall & Sons, Philadelphia
C. M. Hall Lamp Co., Detroit 7
Hanson-Van Winkle-Munning Co., Matawan, N. J.
Hauser-Stander Tank Co., Cincinnati
Haveg Corp., Newark, Del.
Heil Engineering Co., Cleveland
W. A. Hess & Co., Alameda, Cal.
Hobart Brothers Co., Troy, Ohio
J. Holland & Sons, Inc., Brooklyn
Lasalco, Inc., St. Louis
Lea Mfg. Co., Waterbury, Conn.
Chas. F. L'Hommedieu & Sons Co., Chicago
MacDermid Inc., Waterbury, Conn.
Meaker Co., Chicago
J. C. Miller, Co., Grand Rapids, Mich.
Mitchell Engineering Co., Springfield, Ohio
Munning & Munning, Inc., Newark
N. Ransohoff, Inc., Cincinnati
Rapid Electroplating Process, Inc., Chicago
Rapid Process Inc., New York
J. J. Siefen Co., Detroit 9
Sommers Bros. Mfg. Co., St. Louis
Frederic B. Stevens, Inc., Detroit
George A. Stutz Mfg. Co., Chicago
Udylite Corp., Detroit 11

United Chromium, Inc., New York 17
United Engineering & Foundry Co., Pittsburgh
U. S. Galvanizing & Plating Equipment Corp., Brooklyn
Van Der Horst Corp. of America, Cleveland 11
Warner Products Co., Inc., Chicago

Galvanizing Equipment (Hot Dip)

Ajax Electric Furnace Corp., Philadelphia 23
American Machine and Metals, Inc., Tolhurst Centrifugals Div., East Moline, Ill.
Leon J. Barrett Co., Worcester, Mass.
Bellevue Industrial Furnace Co., Detroit 7
Broden Construction Co., Cleveland
Erie Foundry Co., Erie, Pa.
General Electric Co., Schenectady 5, N. Y.
Meaker Co., Chicago 50
Morgan Construction Co., Worcester, Mass.
National Wire Machinery Co., Lynn, Mass.
Pennsylvania Industrial Engineers, Pittsburgh 12
N. Ransohoff, Inc., Cincinnati
Salem Engineering Co., Salem, Ohio
Sleeper & Hartley, Worcester, Mass.
Tate-Jones Co. Inc., Leetsdale, Pa.
United Engineering & Foundry Co., Pittsburgh
U. S. Galvanizing & Plating Equipment Corp., Brooklyn
Vaughn Machinery Co., Cuyahoga Falls, Ohio
Wean Engineering Co., Warren, Ohio
Wire Machinery Corp. of America, Inc., New Haven, Conn.
Youngstown Foundry & Machine Co., Youngstown, Ohio

Infra-Red Equipment

Burdett Mfg. Co., Chicago
Detroit Sheet Metal Works, Detroit
Drying Systems Inc., Chicago
Ferro Enamel Corp., Cleveland
Fostoria Pressed Steel Corp., Fostoria, Ohio
Gehnrich Oven Div., W. G. Rockwell Co., Brooklyn
Gehnrich Oven Div., W. S. Rockwell Co., Fairfield, Conn.
C. M. Hall Lamp Co., Detroit
Infra-Red-Ray Devices, Inc., Clarkston, Mich.
Leeds Electric & Mfg. Co., Hartford, Conn.
Miskella Infra-Red Co., Cleveland
J. J. Siefen Co., Detroit 9
Swenson Engineering Service, Detroit
Trumbull Electric Mfg. Co., Plainville, Conn.
Wabash Appliance Corp., Brooklyn
Wil-Son Mfg. Corp., Chicago

Metallizing Equipment

Detroit Sheet Metal Works, Detroit
Master Metal Spray Co., Oakland, Cal.
Metallizing Co. of America, Chicago
Metallizing Engineering Co., Inc., Long Island City, N. Y.
Metaloy Sprayer Co., New York
Metals Coating Co. of America, Philadelphia
Metalspray Co., Los Angeles
Schori Process Corp., Long Island City, N. Y.
Turner Brass Works, Sycamore, Ill.

Non-Metallic Spraying Equipment

Acme Gear & Machine Co., Philadelphia
American Steel Works, Kansas City, Mo.
Willard C. Beach Air Brush Co., Harrison, N. J.
Binks Mfg. Co., Chicago
Breuer Electric Mfg. Co., Chicago
W. G. Chausse Mfr., Detroit
Clements Mfg. Co., Chicago
Crown Spray Gun Mfg. Co., Los Angeles
Curtis Pneumatic Machinery Co., St. Louis
Dayton Pump & Mfg. Co., Dayton, Ohio
Despatch Oven Co., Minneapolis, Minn.
Detroit Sheet Metal Works, Detroit
DeVilbiss Co., Toledo, Ohio
Dobbins Mfg. Co., Elkhart, Ind.
Eclipse Air Brush Co., Inc., Newark
Electric Sprayit Co., Milwaukee, Wis.
Essick Machinery Co., Los Angeles
Hobart Bros. Co., Troy, Ohio
H. D. Hudson Mfg. Co., Chicago
Ideal Commutator Dresser Co., Sycamore, Ill.
Imperial Brass Mfg. Co., Chicago
Kellogg Div., American Brake Shoe & Foundry Co., Rochester, N. Y.
Lea Mfg. Co., Waterbury, Conn.
Macleod Co., Cincinnati
Metal Specialties Mfg. Co., Chicago
Alexander Milburn Co., Baltimore
Paasche Airbrush Co., Chicago
Parke-Cramer Co., Fitchburg, Mass.
Harper J. Ransberg, Indianapolis, Ind.
Saylor-Beall Mfg. Co., Detroit
William B. Scaife & Sons Co., Oakmont, Pa.
Simmons Paint Spray Brush Co., Dayton, Ohio
Simplex Spray Equipment Co., Chicago
D. R. Smith & Co., Inc., Utica, N. Y.
Spray Engineering Co., Somerville, Mass.
George M. Stowe, Jr., Buffalo, N. Y.
U. S. Air Compressor Co., Cleveland

Ovens (Finishing)

Acme Electric Heating Co., Inc., Boston
Ajax Electric Co., Inc., Philadelphia
American Gas Furnace Co., Elizabeth, N. J.
Associated Industrial Engineers, Inc., Philadelphia
Blaw-Knox Div. of Blaw-Knox Co., Blawnox, Pa.
G. S. Blodgett Co., Burlington, Vt.
Burdett Mfg. Co., Chicago
Carl-Mayer Corp., Cleveland
Cooley Electric Mfg. Corp., Indianapolis 7, Ind.
Despatch Oven Co., Minneapolis, Minn.
Detroit Oven & Metal Fabricators, Inc., Detroit
Detroit Sheet Metal Works, Detroit
Drying Systems, Inc., Chicago
Electric Furnace Co., Salem, Ohio
Electric Heating Equipment Co., Philadelphia
Fostoria Pressed Steel Corp., Fostoria, Ohio
G and M Sheet Metal Works, Detroit
Gehnrich & Gehnrich, Inc., Woodside, N. Y.
Gehnrich Oven Div., W. S. Rockwell Co., Fairfield, Conn.
General Electric Co., Schenectady 5, N. Y.
Geo. J. Hagan Co., Pittsburgh 3
C. M. Hall Lamp Co., Detroit 7
Fred Hover Co., Chicago
K. H. Huppert Co., Chicago
Industrial Oven Engineering Co., Cleveland 2
Kirk & Blum Mfg. Co., Cincinnati
George Koch Sons, Inc., Evansville, Ind.
Lydon Brothers, Jersey City, N. J.
Paul Maehler Co., Chicago 12
R. C. Mahon Co., Detroit 11
Magnus Chemical Co., Inc., Garwood, N. J.
Bruce McDonald Co., Kansas City, Mo.
Metal Equipment Co., Cleveland
Morrison Engineering Corp., Cleveland
National Drying Machinery Co., Philadelphia
Peters-Dalton, Inc., Detroit
Porbeck Mfg. Co., St. Louis
Ransome Co., Emeryville, Cal.
W. S. Rockwell Co., New York
J. O. Ross Engineering Corp., New York
Steiner-Ives Co., Newark
Struthers Wells Corp., Titusville, Pa.
Swartwout Oven Div., Foundry Equipment Co., Cleveland
Tate-Jones & Co., Inc., Pittsburgh
Harold E. Trent Co., Philadelphia
Wagner Litho Machinery Co., Hoboken, N. J.
Young & Bertke Co., Cincinnati

Polishing and Buffing Equipment

Acme Mfg. Co., Detroit
American Instrument Co., Silver Spring, Md.
A. A. Augat Machine & Tool Co., Attleboro, Mass.
Automatic Buffing Machine Co., Buffalo, N. Y.
Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn.
Buehler Ltd., Chicago
Chicago Wheel & Mfg. Co., Chicago 7
James Clark Jr., Electric Co., Louisville, Ky.
Clizbe Bros. Mfg. Co., Plymouth, Ind.
Cratex Mfg. Co., San Francisco
Crown Rheostat & Supply Co., Chicago
Crozier Machine Tool Co., Hawthorne, Cal.
Curtis Machine Corp., Jamestown, N. Y.
Delta Mfg. Co., Milwaukee 1, Wis.
Divine Brothers Co., Utica, N. Y.
DoAll Co., Minnesota Div., Minneapolis, Minn.
Eberbach & Son Co., Ann Arbor, Mich.
Excelsior Tool & Machine Co., East St. Louis, Ill.
Gardner Machine Co., Beloit, Wis.
Graybar Electric Co., New York 17
Hammond Machinery Builders, Inc., Kalamazoo, Mich.
Hanson-Van Winkle-Munning Co., Matawan, N. J.
R. G. Haskins Co., Chicago
Hill Acme Co., Cleveland
Hisey-Wolf Machine Co., Cincinnati
Hobart Brothers Co., Troy, Ohio
J. Holland & Sons, Inc., Brooklyn
Indiana Foundry Mach. & Supply Co., Brazil, Ind.
Charles L. Jarvis Co., Middletown, Conn.
Lasalco, Inc., St. Louis
Lea Mfg. Co., Waterbury, Conn.
Leiman Bros., Inc., Newark
Lewis Roe Mfg. Co., Brooklyn
Chas. F. L'Hommedieu & Sons Co., Chicago
Lupomatic Tumbling Machine Co., New York
MacDermid, Inc., Waterbury, Conn.
Mico Instrument Co., Cambridge, Mass.
J. C. Miller Co., Grand Rapids, Mich.
Mitchell Engineering Co., Springfield, Ohio
Munning & Munning, Inc., Newark
Osborn Mfg. Co., Cleveland
Packer Machine Co., Meriden, Conn.
Production Machine Co., Greenfield, Mass.
Queen City Machine Tool Co., Cincinnati
Rome Machinery Sales & Engineering Co., Rome, N. Y.
Rotor Tool Co., Cleveland
Royersford Foundry & Machine Co., Royersford, Pa.
Schauer Machine Co., Cincinnati
Standard Electrical Tool Co., Cincinnati
Frederic B. Stevens, Inc., Detroit
Stow Mfg. Co., Binghamton, N. Y.
Sundstrand Machine Tool Co., Rockford, Ill.
Udylite Corp., Detroit
Vonnegut Moulders Corp., Indianapolis, Ind.
Walker-Turner Co., Inc., Plainfield, N. J.
Wean Engineering Co., Inc., Warren, Ohio
Wyzenbeek & Staff, Inc., Chicago

Rustproofing, Coloring, Chemical Preheating Equipment

Alvey-Ferguson Co., Cincinnati
American Chemical Paint Co., Ambler, Pa.
Leon J. Barrett Co., Inc., Worcester, Mass.
Despatch Oven Co., Minneapolis, Minn.
Enterprise Galvanizing Co., Philadelphia 25
W. Green Electric Co., Inc., New York
Hanson-Van Winkle-Munning Co., Matawan, N. J.
Hobart Brothers Co., Troy, Ohio
A. F. Holden Co., New Haven 8, Conn.
E. F. Houghton & Co., Philadelphia 33
Howard Engineering & Manufacturing Co., Cincinnati
Industrial Washing Machine Corp., New Brunswick, N. J.
International Rustproof Corp., Lakewood 7, Ohio
Kelite Products Inc., Los Angeles 1
Kondor Products Corp., Lakewood 7, Ohio
Koppers Co., Pittsburgh 19
Lea Mfg. Co., Waterbury, Conn.
R. C. Mahon Co., Detroit 11
Metalwash Machinery Co., Irvington, N. J.
Nox-Rust Corp., Chicago 8
Oakite Products Inc., New York 6
Optimus Equipment Co., Matawan, N. J.
Parker Rust Proof Co., Detroit 11
Phillips Manufacturing Co., Chicago
Rheem Research Products Inc., Baltimore 17
Turco Products Inc., Los Angeles 54
Udylite Corp., Detroit 11

Tinning Equipment (Hot Dip)

Aetna-Standard Engineering Co., Youngstown 1, Ohio
American Insulating Machinery Co., Philadelphia
American Shear Knife Co., Homestead, Pa.
Erie Forge Co., Erie, Pa.
C. M. Kemp Mfg. Co., Baltimore 2
National Annealing Box Co., Washington, Pa.
Sleeper & Hartley, Worcester, Mass.
U. S. Galvanizing & Plating Equipment Corp., Brooklyn
United Engineering & Foundry Co., Pittsburgh
Vaughn Machinery Co., Cuyahoga Falls, Ohio
Wean Engineering Co. Inc., Warren, Ohio
Wire Machinery Corp. of America, Inc., New Haven, Conn.

Inspection and Testing

Mechanical Testing

Compression Testing Equipment

American Machine and Metals, Inc., East Moline, Ill.
Baldwin Southwark Div., Baldwin Locomotive Works, Eddystone, Pa.
Commercial Research Laboratories, Detroit
Detroit Testing Machine Co., Detroit
W. C. Dillon & Co., Inc., Chicago
Fisher Scientific Co., Pittsburgh
Herman A. Holz, New York
Link Engineering Co., Detroit
Steel City Testing Laboratory, Detroit
Testing Machines, Inc., New York
Toledo Scale Co., Toledo, Ohio
Watson-Stillman Co., Roselle, N. J.

Hardness Testing Equipment

Abrasive Engineering Corp., Spring Lake, Mich.
American Machine and Metals, Inc., East Moline, Ill.
American Optical Co., Buffalo, N. Y.
B. C. Ames Co., Waltham, Mass.
Barber-Colman Co., Rockford, Ill.
Adolph I. Buehler, Chicago
Clark Instruments, Dearborn, Mich.
Dearborn Tool & Die Co., Dearborn, Mich.
Detroit Testing Machine Co., Detroit
Eberbach & Son Co., Ann Arbor, Mich.
Louis C. Eitzen Co., New York
R. Y. Ferner Co., Boston
Fisher Scientific Co., Pittsburgh
General Electric Co., Schenectady, N. Y.
Gogan Machine Corp., Cleveland
Claud S. Gordon Co., Chicago
Herman A. Holz, New York
Industrial Diamond Co., Inc., Detroit
Andrew King, Narberth, Pa.
Tinius Olsen Testing Machine Co., Philadelphia
Pittsburgh Instrument & Machine Co., Pittsburgh
Precision Scientific Co., Chicago
Riehle Testing Machines Div., East Moline, Ill.
Rubicon Co., Philadelphia
Shore Instrument & Mfg. Co., Inc., Jamaica, N. Y.
Steel City Testing Laboratory, Detroit
Steeltest Instrument & Mfg. Co., Detroit
Teleweld, Inc., Chicago
Testing Machines, Inc., New York
Wilson Mechanical Instrument Co., Inc., New York
York Electric & Machine Co., York, Pa.
York Tool Sales Co., York, Pa.

Impact Testing Equipment

American Machine and Metals, Inc., East Moline, Ill.
Baldwin Southwark Div., Baldwin Locomotive Works, Eddystone, Pa.
Cambridge Instrument Co., New York
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago
H-W Manufacturing Co., Urbana, Ill.
Herman A. Holz, New York
L. A. R. Corp., Summit, N. J.
Testing Machine, Inc., New York
Thwing-Albert Instrument Co., Philadelphia
Tinius Olsen Testing Machine Co., Philadelphia
Riehle Testing Machines Div., East Moline, Ill.
Sonntag Scientific Corp., Greenwich, Conn.
Steel City Testing Laboratory, Detroit

Tensile and Bend Testing Equipment

American Machine & Metals, Inc., East Moline, Ill.
Amthor Testing Instrument Co., Brooklyn
Ann Arbor Instrument Works, Ann Arbor, Mich.
Baldwin-Southwark Div., Baldwin Locomotive Works, Eddystone, Pa.
John Chatillon & Sons, New York
Detroit Testing Machine Co., Detroit
W. C. Dillon & Co., Inc., Chicago
R. Y. Ferner Co., Boston
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago
H-W Manufacturing Co., Urbana, Ill.
Hayes Scientific Appliances, Urbana, Ill.
Herman A. Holz, New York
Tinius Olsen Testing Machine Co., Philadelphia
Riehle Testing Machines Div., East Moline, Ill.
Scott Testers, Inc., Providence, R. I.
Sonntag Scientific Corp., Greenwich, Conn.
Steel City Testing Laboratory, Detroit
Taber Instrument Corp., North Tonawanda, N. Y.
Testing Machines, Inc., New York
Thwing-Albert Instrument Co., Philadelphia
Toledo Scale Co., Toledo, Ohio

Torsion Testing Equipment

Ann Arbor Instrument Works, Ann Arbor, Mich.
Baldwin Southwark Div., Baldwin Locomotive Works, Eddystone, Pa.
Detroit Testing Machine Co., Detroit
Claud S. Gordon Co., Chicago
H-W Manufacturing Co., Urbana, Ill.
Herman A. Holz, New York
Krouse Testing Machine Co., Columbus
Kurman Electric Co., Inc., Long Island City, N. Y.
Tinius Olsen Testing Machine Co., Philadelphia
H. Z. Schniewind, Eddystone, Pa.
Scott Testers, Inc., Providence, R. I.
Sonntag Scientific Corp., Greenwich, Conn.
Steel City Testing Lab., Detroit
Testing Machines, Inc., New York

Transverse and Shear Testing Equipment

American Machine and Metals, Inc., East Moline, Ill.
Baldwin Southwark Div., Baldwin Locomotive Works, Eddystone, Pa.
W. C. Dillon & Co., Inc., Chicago
Tinius Olsen Testing Machine Co., Philadelphia
Steel City Testing Lab., Detroit
Testing Machines, Inc., New York
Toledo Scale Co., Toledo, Ohio

Non-Destructive Testing and Inspection

Balancing Machines and Instruments

Anderson Bros. Mfg. Co., Rockford, Ill.
Chicago Pneumatic Tool Co., New York
Commerce Pattern Foundry & Machine Co., Detroit
General Electric Co., Schenectady, N. Y.
Gisholt Machine Co., Madison 3, Wis.
Globe Tool & Engineering Co., Dayton, Ohio
Ideal Commutator Dresser Co., Sycamore, Ill.
Lord Mfg. Co., Erie, Pa.
Norton Co., Worcester, Mass.
Tinius Olsen Testing Machine Co., Philadelphia
Pfaltz & Bauer, Inc., New York
Pope Machinery Corp., Haverhill, Mass.
Snyder Tool & Engineering Co., Detroit 7
Sundstrand Machine Tool Co., Rockford, Ill.
Taft Pierce Mfg. Co., Woonsocket, R. I.
Taylor Mfg. Co., Milwaukee, Wis.
Toledo Scale Co., Toledo, Ohio
Westinghouse Electric Corp., E. Pittsburgh, Pa.

Comparators, optical measuring

DoAll Co., Minneapolis, Minn.
Engineers Specialties Div. of Universal Engraving & Colorplate Co., Inc., Buffalo, N. Y.
Fish-Schurman Corp., New York
Jones & Lamson Machine Co., Springfield, Vt.
James A. Mahoney Co., Inc., Newark
Portman Machine Tool Co., New Rochelle, N. Y.
Rex Laboratories, Indianapolis, Ind.
George Scherr Co., New York
Triplex Machine Tool Corp., New York
Wickman Corp., Detroit

Fluorescent Penetrant Equipment

Magnaflux Corp., Chicago

Magnetic Analysis Equipment

Allen B. DuMont Laboratories, Inc., Passaic, N. J.
Magnetic Analysis Corp., Long Island City, N. Y.

Magnetic Particle Equipment

General Electric Co., Schenectady, N. Y.
Magnaflux Corp., Chicago

Radiographic Equipment

Buck X-Ograph Co., St. Louis
Canadian Radium & Uranium Corp., New York
Dick X-Ray Co., St. Louis
Eastman Kodak Co., Rochester, N. Y.
General Electric Co., Schenectady, N. Y.
H-W Manufacturing Co., Urbana, Ill.
Hayes Scientific Appliances, Urbana, Ill.
Kelley-Koett Mfg. Co., Covington, Ky.
North American Philips Co., Inc., New York
Pako Corp., Minneapolis, Minn.
Picker X-Ray Corp., New York
Radium Chemical Co., Inc., New York
Radium Industries, Inc., Chicago
Ray Proof Corp., New York
Renco, Inc., Deerfield, Mich.
St. John X-Ray Service, Inc., Long Island City, N. Y.
Standard X-Ray Co., Inc., Chicago
Universal X-Ray Products, Inc., Chicago
Westinghouse Electric Corp., Baltimore

Spectrographic Equipment

American Optical Co., Buffalo, N. Y.
Applied Research Labs., Glendale, Cal.
Bausch & Lomb Optical Co., Rochester, N. Y.
Adolph I. Buehler, Chicago
Burrell Technical Supply Co., Pittsburgh
Chicago Apparatus Co., Chicago
Consolidated Engineering Corp., Pasadena, Cal.
Eberbach & Son Co., Ann Arbor, Mich.
R. Y. Ferner Co., Washington, D. C.
Gaertner Scientific Corp., Chicago
General Electric Co., Schenectady, N. Y.
Hayes Scientific Appliances, Urbana, Ill.
Leeds & Northrup Co., Philadelphia
Macalaster Bicknell Co., New Haven, Conn.
Mico Instrument Co., Cambridge, Mass.
National Technical Laboratories, So. Pasadena, Cal.
Pfaltz & Bauer, Inc., New York
W. M. Welch Mfg. Co., Chicago
Carl Zeiss, Inc., New York

Supersonic Equipment

Brush Development Co., Cleveland
General Electric Co., Schenectady, N. Y.
Sperry Products, Inc., Hoboken, N. J.

Surface Roughness Equipment

Brush Development Co., Cleveland
General Electric Co., Schenectady, N. Y.
Physicists Research Co., Ann Arbor, Mich.
Size Control Co., Chicago

Special Characteristics Testing

Corrosion Testing Equipment

American Instrument Co., Silver Spring, Md.
Krouse Testing Machine Co., Columbus
Munning & Munning Inc., Newark

Creep, Drift, Extension Testing Equipment

R. Y. Ferner Co., Boston
General Electric Co., Schenectady, N. Y.
Herman A. Holz, New York
Krouse Testing Machine Co., Columbus
Scott Testers, Inc., Providence, R. I.
Sonntag Scientific Corp., Greenwich, Conn.

Fatigue Testing Equipment

All American Tool & Mfg. Co., Chicago
Ann Arbor Instrument Wks., Ann Arbor, Mich.

Baldwin Southwark Div., Baldwin Locomotive Works, Eddystone, Pa.
W. C. Dillon Co., Inc., Chicago
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago
H-W Manufacturing Co., Urbana, Ill.
Hayes Scientific Appliances, Urbana, Ill.
Herman A. Holz, New York
Krouse Testing Machine Co., Columbus
L. A. B. Corp., Summit, N. J.
Tinius Olsen Testing Machine Co., Philadelphia
Raytheon Mfg. Co., Waltham, Mass.
Scott Testers, Inc., Providence, R. I.
Sonntag Scientific Corp., Greenwich, Conn.
Sperry Products, Inc., Hoboken, N. J.
Televiso Products Co., Chicago
Testing Machines, Inc., New York
Waugh Equipment Co., New York
Westinghouse Electric Corp., E. Pittsburgh, Pa.

Stress Analysis Equipment

American Instrument Co., Silver Spring, Md.
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia
Brush Development Co., Cleveland
Cole Instrument Co., Los Angeles
Federal Products Corp., Providence, R. I.
Gaertner Scientific Corp., Chicago
General Electric Co., Schenectady, N. Y.
Kurman Electric Co., Inc., Long Island City, N. Y.
Magnaflux Corp., Chicago
Metron Instrument Co., Denver
E. H. Sargent & Co., Chicago
Televiso Products Co., Los Angeles

Wear Testing Equipment

American Instrument Co., Silver Spring, Md.
Amthor Testing Instrument Co., Inc., Brooklyn
General Electric Co., Schenectady, N. Y.
Herman A. Holz, New York
L. A. B. Corp., Summit, N. J.
Tinius Olsen Testing Machine Co., Philadelphia
Saxl Instrument Co., East Providence, R. I.
H. Z. Schniewind, New York
Taber Instrument Corp., North Tonawanda, N. Y.
Testing Machines, Inc., New York

Process Control and Instrumentation

Pyrometers (Optical)

Brown Instrument Co., Div., Minneapolis-Honeywell Regulator Co., Philadelphia
Adolph I. Buehler, Chicago
Cambridge Instrument Co., Inc., New York
Fisher Scientific Co., Pittsburgh
Leeds & Northrup Co., Philadelphia
Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Pyrometer Instrument Co., New York

Pyrometers (Radiation)

Bristol Co., Instrument Div., Waterbury, Conn.
Leeds & Northrup Co., Philadelphia
Pyrometer Instrument Co., New York
C. J. Tagliabue, Div., Portable Products Corp., Brooklyn
Thwing-Albert Instrument Co., Philadelphia
Wheelco Instruments Co., Chicago

Pyrometers (Thermoelectric)

Alnor Inst. & Pyrometer Co., Chicago
Bailey Meter Co., Cleveland
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia
Burrell Technical Supply Co., Pittsburgh
Cole Instrument Co., Los Angeles
Defender Instrument & Regulator Co., St. Louis
Electro-Tech Equipment Co., New York
Elematic Equipment Corp., Chicago
Chas. Engelhard, Inc., Newark
Foxboro Co., Foxboro, Mass.
General Electric Co., Schenectady, N. Y.
Claud Gordon & Co., Chicago
Hoskins Mfg. Co., Detroit
K. H. Huppert Co., Chicago
Illinois Testing Laboratories, Inc., Chicago
Instrument Engineering Corp., Indianapolis, Ind.
J-B-T Instruments, Inc., New Haven, Conn.
Leeds & Northrup Co., Philadelphia
Lewis Engineering Co., Naugatuck, Conn.
L. H. Marshall Co., Columbus, Ohio
Norton Electrical Instrument Co., Manchester, Conn.
Partlow Corp., New Hartford, N. Y.
Pyrometer Service Co., North Arlington, N. J.
Arklay S. Richards Co., Inc., Newton Heights, Mass.
Rubicon Co., Philadelphia
Scientific Instrument Co., Detroit
Standard Apparatus Co., Chicago
C. J. Tagliabue, Div., Portable Products Corp., Brooklyn
Tamms Silica Co., Chicago
Thermo-Electric Co., Fair Lawn, N. J.
Thwing-Albert Instrument Co., Philadelphia
Westinghouse Electric Corp., E. Pittsburgh, Pa.
Western Instrument Co., Los Angeles
Wheelco Instruments Co., Chicago
Winslow Co., Newark

Temperature Indicating and Recording Instruments

American Schaeffer & Budenbuerg Instrument Div. of Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
American Temperature Indicating Co., Toledo, Ohio
Bailey Meter Co., Cleveland
Brown Instrument Co., Philadelphia
Burlington Instrument Co., Burlington, Iowa
Eclipse Pioneer Div. of Bendix Aviation Corp., Teterboro, N. J.
Electric Eye Equipment Co., Danville, Ill.
Chas. Engelhard, Inc., Newark
Foxboro Co., Foxboro, Mass.
Friez Instrument Div., Bendix Aviation Corp., Towson, Md.
General Electric Co., Schenectady 5, N. Y.
Gotham Instrument Co., New York
Graybar Electric Co., New York 17
Hays Corp., Michigan City, Ind.
Illinois Testing Laboratories, Inc., Chicago
J-B-T Instruments, Inc., New Haven, Conn.
Johnston Mfg. Co., Minneapolis, Minn.
Leeds & Northrup Co., Philadelphia
Partlow Corp., New Hartford, N. Y.
Arklay S. Richards Co., Inc., Newton Highlands, Mass.
Rochester Mfg. Co., Inc., Rochester, N. Y.
Sheffield Corp., Dayton 1, Ohio
Herman H. Sticht Co., New York 7
C. J. Tagliabue Div., Portable Products Corp., New York
Taylor Instrument Co., Rochester, N. Y.
Thwing-Albert Instrument Co., Philadelphia
Westinghouse Electric Corp., E. Pittsburgh, Pa.
Wheelco Instruments Co., Chicago

Temperature Controllers

Automatic Temperature Control Co., Inc., Philadelphia
Bailey Meter Co., Cleveland
Barber-Colman Co., Rockford, Ill.
Bell & Gossett Co., Morton Grove, Ill.
Besler Corp., Emeryville, Cal.
Brown Instrument Co., Philadelphia
Burling Instrument Co., Newark
Cooley Electric Mfg. Corp., Indianapolis 7, Ind.
Denver Fire Clay Co., Denver
Electric Eye Equipment Co., Danville, Ill.
Charles Engelhard, Inc., Newark
Enthone Co., New Haven, Conn.
Fischer & Porter Co., Hatboro, Pa.
Foxboro Co., Foxboro, Mass.
General Controls Co., Glendale, Cal.
General Electric Co., Schenectady, N. Y.
Hays Corp., Michigan City, Ind.
Hays Corp., Michigan City, Ind.
Illinois Testing Laboratories, Inc., Chicago
J-B-T Instruments, New Haven, Conn.
Leeds & Northrup Co., Philadelphia
Mercoid Corp., Chicago
North American Laboratories, Inc., North Plainfield, N. J.
Parker-Kalon Corp., New York
Partlow Corp., New Hartford, N. Y.
Payne Furnace Co., Beverly Hills, Cal.
Pioneer Air Compressor Co., Inc., New York
Pyrometer Service Co., North Arlington, N. J.
R-S Products Corp., Philadelphia
Sheffield Corp., Dayton 1, Ohio
C. J. Tagliabue, Div., Portable Products Corp., Brooklyn
Thwing-Albert Instrument Co., Philadelphia
N. J. Towaco, Palmyra, N. J.
Westinghouse Electric Corp., E. Pittsburgh, Pa.
Wheelco Instruments Co., Chicago

General Plant Equipment

Air Conditioning and Cleaning Equipment

R. P. Adams Co., Inc., Buffalo 4, N. Y.
American Air Filter Co., Inc., Louisville 8, Ky.
Carrier Corp., Syracuse, N. Y.
Chrysler Corp., Airtemp Div., Dayton, Ohio
General Electric Co., Air Conditioning & Refrigeration Div., Bloomfield, N. J.
Pesco Products Co., Cleveland 6
Westinghouse Electric & Mfg. Co., Cleveland 1
Moraine Products Div., General Motors Corp., Dayton 1, Ohio
York Ice Machinery Corp., York, Pa.

Dust Collectors

American Air Filter Co., Inc., Louisville, Ky.
American Foundry Equipment Co., Mishawaka, Ind.
C. O. Bartlett & Snoe Co., Cleveland
Detroit Sheet Metal Works, Detroit
Leiman Bros., Inc., Newark
Macleod Co., Cincinnati
Peoria Sand Blast Mfg. Co., Peoria, Ill.
Claude B. Schneible Co., Chicago
W. W. Sly Manufacturing Co., Cleveland
Surty Mfg. Co., Inc., Chicago
Torit Mfg. Co., St. Paul, Minn.
Whiting Corp., Harvey, Ill.

Heat Exchangers

Atlas Press Co., Kalamazoo, Mich.
Babcock & Wilcox Co., New York 6
Bell & Gossett Co., Morton Grove, Ill.
Blaw-Knox Div. of Blaw-Knox Co., Blawnox, Pa.
Drayer-Hanson, Inc., Los Angeles
Duriron Co., Inc., New York
General Electric Co., Bloomfield, N. J.
Goslin-Birmingham Mfg. Co., Birmingham, Ala.
Graybar Electric Co., New York 17
Graver Tank & Mfg. Co., E. Chicago, Ind.
Ingersoll-Rand Co., New York 4
Kold-Hold Mfg. Co., Lansing, Mich.
National Carbon Co. Inc, New York 17
Niagara Blower Co., New York 17
Ross Heater & Mfg. Co. Inc., Buffalo 13, N. Y.
Salem Engineering Co., Salem, Ohio
Standard Tube Co., Detroit 3
Struthers Wells Corp., Titusville, Pa.
Westinghouse Elec. & Mfg. Co., Springfield 2, Mass.

Vacuum Pumps

Distillation Products, Inc., Rochester, N. Y.
Eisler Engineering Co., Newark
Kinney Mfg. Co., Boston

CONTENTS NOTED

A monthly department dedicated as a forum for the interchange of ideas between readers and editors. All readers are urged to take advantage of this space and participate in the discussions presented.

Welding Stainless Steel

To the Editor:

I have recently read the article "Welding Stainless Steel—Part I" by C. C. Hermann (MATERIALS & METHODS, March 1946, pp. 713-716). This is an excellent article. There are, however, some things which I feel should be clarified.

For example, on page 713, as stated, the most popular stainless is the 18:8 group. However, there were omitted Type 321, which is titanium stabilized, and Type 347, which is columbium stabilized. These types are widely used in welding fabrication because they prevent carbide precipitation.

The selection of a welding rod having slightly less carbon will not prevent carbide precipitation in part being welded. Using stainless of the 321 or 347 type will prevent carbide precipitation in the parent metal, and use of a type 347 electrode will prevent carbide precipitation in the weld metal.

Titanium (Type 321) rod is not used to prevent carbide precipitation because most of the titanium would be oxidized in the arc.

The last paragraph on page 714 of the article implies that the machine setting is changed because of the increased electrical resistance of the electrode. The machine setting is not changed from 60 amp. when welding mild steel for this reason. The electrical resistance of the electrode has very little effect on the current that a welding machine will produce at a given setting. If it did, it would be impractical to make electrodes 18 in. long.

The machine setting is changed because a larger electrode is used in welding the mild steel than in welding the stainless steel. The maximum current which may be used on a given size electrode is less with a stainless steel electrode than with one of mild steel.

Normally, electrodes are not operated at a current above which the electrode stub will be red hot. Since the electrical resistance of stainless steel electrodes is much higher than that of mild steel electrodes, the maximum current which can be used is less for stainless steel electrodes.

L. K. Stringham

The Lincoln Electric Co.
Cleveland 1, Ohio

It has also been pointed out that some of the stainless steels referred to in Mr. Hermann's article are now obsolete. Those mentioned in the article, and which are now on the obsolete list, are Types 305, 307 and 320.—The Editors.

Precision Casting Dimensions

To the Editor:

In "Materials & Methods Manual" No. 13 in your March issue, I wonder if this statement is correct: "The typical precision casting . . . has no section thicker than 0.25 in. or thinner than 0.40 in." (page 747).

Ernest Reich

Forest Hills, N. Y.

The statement quoted contains an obvious typographical error, the correct figures being 0.25 in. and 0.04 in.—The Editors.

Chemical Finishes for Aluminum

To the Editor:

I read over very carefully "Materials & Methods Manual" No. 12 pertaining to wrought aluminum alloys. In general, the section is very well written. However, I would like to make some comments regarding the section on finishing.

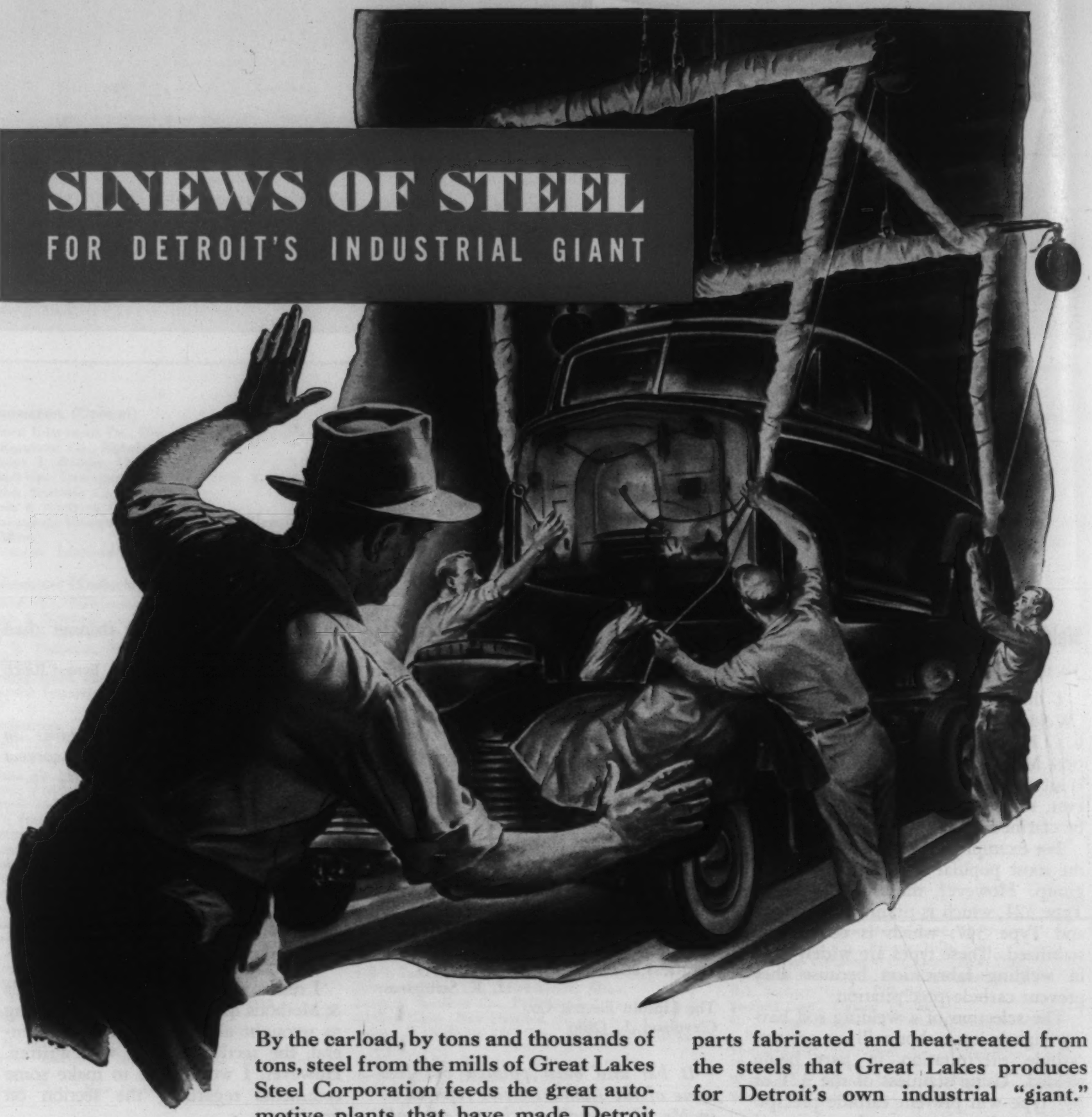
In discussing chemical finishes, it is stated "The Alrok process employs a hot, weak solution of sodium carbonate." This, of course, is not true because a weak solution of sodium carbonate would only etch aluminum surfaces and not produce any oxide finish. Solutions of this type contain sodium carbonate and chromates which are sometimes added as dichromate using potassium dichromate.

I believe it would have been wise to mention that the "Alrok" process is a proprietary process sold by the Aluminum Co. of America, and there are

(Continued on page 1613)

SINEWS OF STEEL

FOR DETROIT'S INDUSTRIAL GIANT



By the carload, by tons and thousands of tons, steel from the mills of Great Lakes Steel Corporation feeds the great automotive plants that have made Detroit the Motor Capital of the world.

Here it is transformed through the miracle of modern engineering and mass-production techniques into cars, trucks and buses: A sheet of steel becomes a beautifully designed, smoothly contoured body; formed sections are welded into a sturdy, rigid frame; fenders are blanked and drawn to shape; scores of parts fabricated and heat-treated from the steels that Great Lakes produces for Detroit's own industrial "giant."

Great Lakes Steel Corporation takes great pride in its assignment as a major steel supplier to the automotive industry. On this Golden Jubilee, we join in acclaiming the vision that "put the world on wheels" . . . the vision that has provided greater value in motor cars and vehicles, year after year, since the first car drove the streets of Detroit.

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UNIT OF NATIONAL STEEL CORPORATION

CONTENTS NOTED

(Continued from page 1611)

other processes for treating aluminum, notably, the "Pylumin" process sold by the Pyrene Mfg. Co., Newark, N. J., and the "Alumox" process sold by Enthone, Inc., New Haven, Conn.

Incidentally, you are not consistent with your spelling of the word "Alrok".

In regard to electroplating upon aluminum, it is stated that zinc can be plated directly upon aluminum from cyanide solutions but, to date, we have not found this possible, due to the high alkalinity of the standard cyanide zinc solutions. It has been possible, however, to electroplate brass, cadmium, silver, nickel and copper directly upon the zinc film deposited from zincate solutions such as the "Alumon" solution of Enthone, Inc.

The sentence "Chromium, copper and the precious metals are usually deposited on an undercoat of nickel" is not generally true. In fact, the reverse is usually done; that is, copper is deposited upon the aluminum and nickel deposited upon the copper.

I would like to congratulate you on the fine job that you are doing with MATERIALS & METHODS.

Dr. Walter R. Meyer

Enthone, Inc.,
New Haven, Conn.

Our thanks to Dr. Meyer for his comments on the finishing of aluminum. Recent strides in protective and decorative finishes for aluminum are of increasing importance, particularly methods of plating aluminum with brass, cadmium, nickel, silver and copper.—The Editors.

Musical Technicians

To the Editors:

While it is true that your regular feature "Production Frontiers" is one section of the magazine which always is read before the regular accumulation of correspondence and periodicals buries it (as it frequently does), your presentation of "We Never Mention Aunt Clara" was so inspiring that I sat down and read the whole magazine.

Would it be possible to have a copy of this song in its entirety? The name of the air to which it is to be sung will enable our laboratory quartette to win the prize at the engineering department picnic—and we'll see that you receive proper credit.

George Kingsbury

Cleveland, Ohio

We are glad to welcome reader Kingsbury into the "We Never Mention Aunt Clara" Society. All that is needed to join is a sense of humor and an ability to carry your share of a tune. —The Editors.

Choice of Steels

To the Editor:

An item of interest to me in the March issue of MATERIALS & METHODS is the article: "Subzero Treatment Simplifies Hardening of Alloy Carburizing Steels" (page 730). I wonder if a different choice of steel would have overcome the problem of excessive hardenability on parts with ¼-in. section made of very high alloy steel. It would seem to me that better results could have been obtained—and without difficulties—if a steel such as NE 8615 or even 1315 or 1320 were used.

H. T. Alois

Pittsburgh, Penna.

There seems to be logic in Mr. Alois' comment. If any other readers have differing opinions, we would be glad to hear of them.—The Editors.

Materials & Methods Manuals

To the Editor:

We have just had brought to our attention the February copy of MATERIALS & METHODS, containing "Materials & Methods Manual" No. 12 (Wrought Aluminum Alloys).

If all the former issues have treated their respective subjects as clearly and completely as the issue referred to above, you are to be congratulated upon a fine compilation of essential facts—a source of reference sorely needed in every engineering and manufacturing organization.

We would appreciate reprints of the several manuals to date, should they be available. They will be most useful as reference sheets to be included in our design files.

James A. Roberts

Valley Engineers,
Glendale, Calif.

All manuals are issued in reprint form. At the present time there are available reprints of the following:

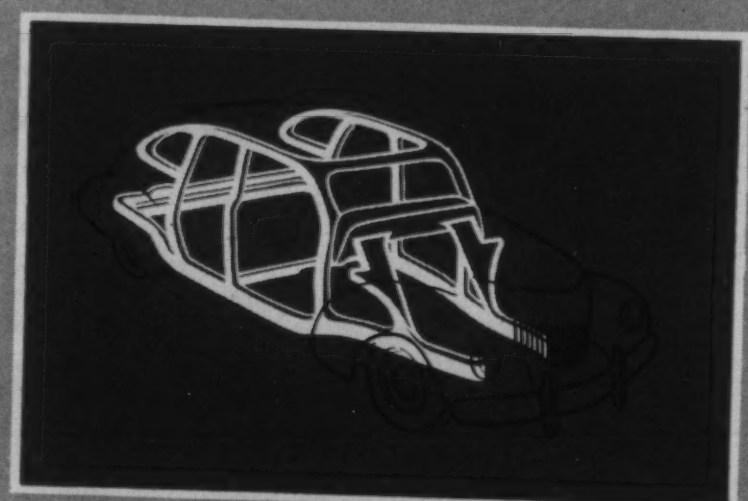
No. 6—Heat Treatment of Steel
No. 7—Cutting Oils
No. 8—Standard Engineering Steels
No. 9—Materials for Peacetime Products
No. 10—Die Castings
No. 11—Stainless Steels
No. 12—Selecting Wrought Aluminum Alloys
No. 13—Precision Investment Castings
No. 14—Engineering Bronzes

Earlier manuals may be available again at a later date if interest warrants. A charge of 25 cents each is made for reprints sold in small quantities.—The Editors.

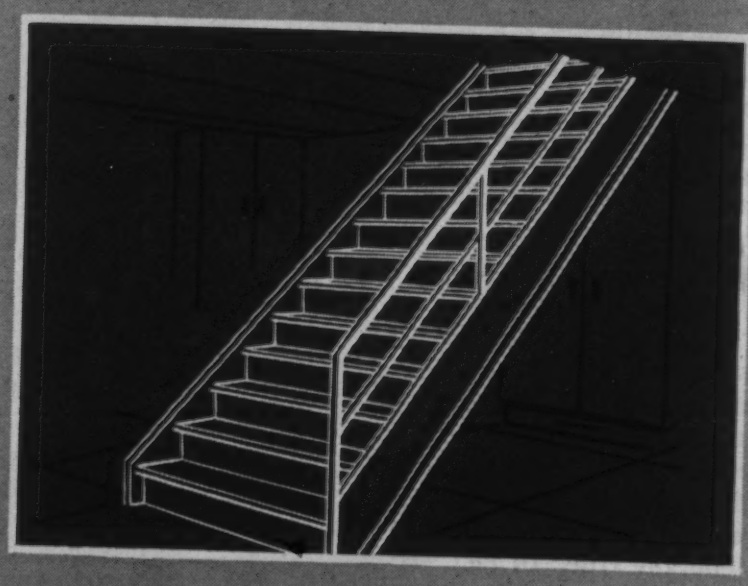
"STEEL

We can help you CASH IN on Steel's advantages

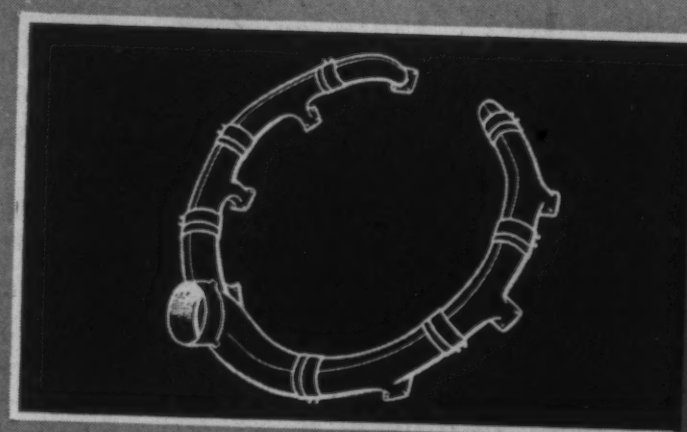
Perhaps you are not making the most of Steel's advantages in the design and manufacture of your products. As the world's largest maker of Steel, we can offer you complete counsel as to how this versatile material can work for you. The right steel in the right application saves money... and makes money by improving product acceptance. Write us for free metallurgical help.



STIFFER FRAMES for the new model cars are made possible through Steel's ability to be cut, formed and welded into a one-piece bridge-like structure. Steel's superior fabricability gives the designer a free hand to create a better product at no increase in cost.



PREFABRICATED stairways, closets and other architectural units offer endless opportunities to capitalize on Steel's sales appeal. Many fabricators use U·S·S PaintBond Galvanized Sheets for such products because they can be painted so successfully.



10,000 HOURS of high-temperature service on an American Airlines flagship is the record of this U·S·S Stainless Steel exhaust manifold. Wherever such extreme resistance to heat and corrosion is a must, you can't beat Stainless!

Only STEEL can do so many jobs so well

MATERIALS & METHODS Engineering File Facts

NUMBER 115
June, 1946

MATERIALS: Aluminum Alloys

Shear Properties of Metals and Alloys

Part 2: Aluminum Alloys

This is the second part of a tabulation of the shear properties of common engineering metals and alloys; Part 3, to be published in a forthcoming issue of MATERIALS & METHODS, *will include the shear properties of magnesium alloys*

Aluminum Alloys (Wrought)

Material Specifications			Typical Shear Properties[2]	
ASTM	SAE	Alcoa	Shear Str. Psi.	Ratio of Shear to Tensile Strength
B25-44T	25	2S-O	9,500	0.73
		2S-¼H	10,000	0.66
		2S-½H	11,000	0.65
		2S-¾H	12,000	0.60
		2S-H	13,000	0.54
B79-44T B126-44T	29	3S-O	11,000	0.69
		3S-¼H	12,000	0.67
		3S-½H	14,000	0.67
		3S-¾H	15,000	0.60
		3S-H	16,000	0.55
—	—	11S-T3[3]	30,000	0.57
		11S-T8	33,000	0.58
—	—	14S-O	18,000	0.67
		14S-W	34,000	0.61
		14S-T	42,000	0.60
B78-44T B89-44T	26	17S-O	18,000	0.69
		17S-T	38,000	0.61
—	—	A17S-T	28,000	0.65
—	24	24S-O	18,000	0.67
		24S-T	41,000	0.60
		24S-RT	42,000	0.58
—	240	Alclad 24S-T	40,000	0.63[4]
		Alclad 243-RT	41,000	0.61[4]
B109-44T	201	52S-O	18,000	0.62
		52S-¼H	20,000	0.63
		52S-½H	21,000	0.57
		52S-¾H	23,000	0.59
		52S-H	24,000	0.59
—	—	53S-O	11,000	0.69
		53S-W	20,000	0.61
		53S-T	24,000	0.62
—	—	61S-O	12,500	0.69
		61S-W	24,000	0.69
		61S-T	30,000	0.67
—	—	75S-T[5]	47,000	0.53
—	—	Alclad 75S-T	46,000	0.61

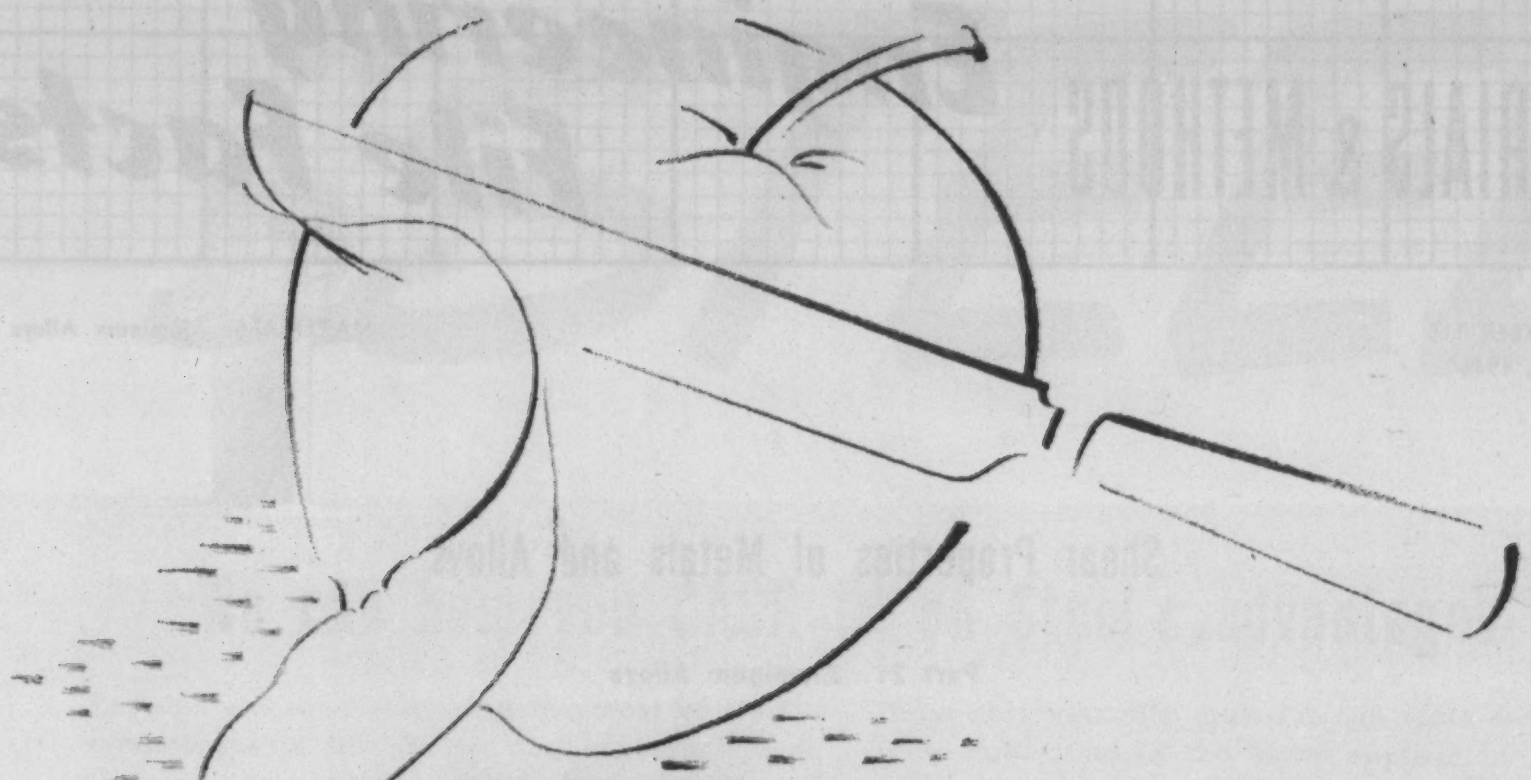
[2] *Data taken from circular C447, National Bureau of Standards, and from publications of the Aluminum Company of America*

[3] *For sizes up to 1½ in.; values are lower for larger sizes*

[4] *Tensile strength is higher (ratio of shear to tensile strength is lower), for sheets over 0.064 in. thick*

[5] *Extrusions*

(Continued on page 1619)



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They are solid and close-grained immediately under the surface. You will get more usable metal per pound of rough casting and save machining time with only a little "skin" to cut through.

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NUMBER 115 (Continued)

SHEAR PROPERTIES OF METALS AND ALLOYS, Part 2

	Material Specifications			Typical Shear Properties[2]	
	ASTM	SAE	Alcoa	Shear Str. Psi.	Ratio of Shear to Tensile Strength
Aluminum Alloys (Sand Castings)	B26-44T, Alloy S1	35	43	14,000	0.74
	—	—	47[6]	18,000	0.69
	—	—	108	20,000	0.95
	—	—	112	20,000	0.83
	—	—	112-T2	21,000	0.78
			112-T61	29,000	0.73
	—	—	142-T2	21,000	0.78
			142-T61	32,000	0.87
			142-T571	27,000	0.84
	—	—	195-T4[7]	24,000	0.75
			195-T6	30,000	0.83
			195-T62	31,000	0.78
	—	—	212	20,000	0.87
	—	—	214	20,000	0.80
	—	—	220-T4	33,000	0.72
	—	—	A334	24,000	0.96
	—	—	355-T6	30,000	0.86
			355-T51	22,000	0.79
	—	—	A355-T59	21,000	0.84
	—	—	356-T6	27,000	0.82
			356-T51	18,000	0.72
	—	—	645[7]	22,000	0.76

	Material Specifications			Typical Shear Properties[2]	
	ASTM	SAE	Alcoa	Shear Str. Psi.	Ratio of Shear to Tensile Strength
Aluminum Alloys (Permanent Mold Castings)	B108-44T, Alloy S1	35	43	18,000	0.75
	—	—	A108	25,000	0.89
	—	—	B113	23,000	0.82
			C113	22,000	0.73
			C113-T2	19,000	0.70
	—	—	122-T52	25,000	0.72
			122-T65	30,000	0.63
			122-T551	27,000	0.73
			122-T553	21,000	0.62
	—	—	A132-T4	29,000	0.74
			A132-T551	24,000	0.67
	—	—	138	22,000	0.79
	—	—	142-T61	31,000	0.66
			142-T571	26,000	0.65
	—	—	B195-74[7]	30,000	0.75
			B195-T6	32,000	0.71
	—	—	A214	22,000	0.82
	—	—	355-T51	24,000	0.80
			355-T6	30,000	0.70

[2] *Data taken from circular C447, National Bureau of Standards, and from publications of the Aluminum Company of America*

[6] *Properties of this alloy obtained by special foundry practice called "modification"*

[7] *On standing at room temperature for several weeks, the tensile strength (and yield strength) will increase slightly while the elongation will be reduced somewhat; alloys 195-T4 and B195-T4 will tend to have properties approaching those of 195-T6 and B195-T6, respectively*

Compiled by Robert S. Burpo Jr., Associate Editor

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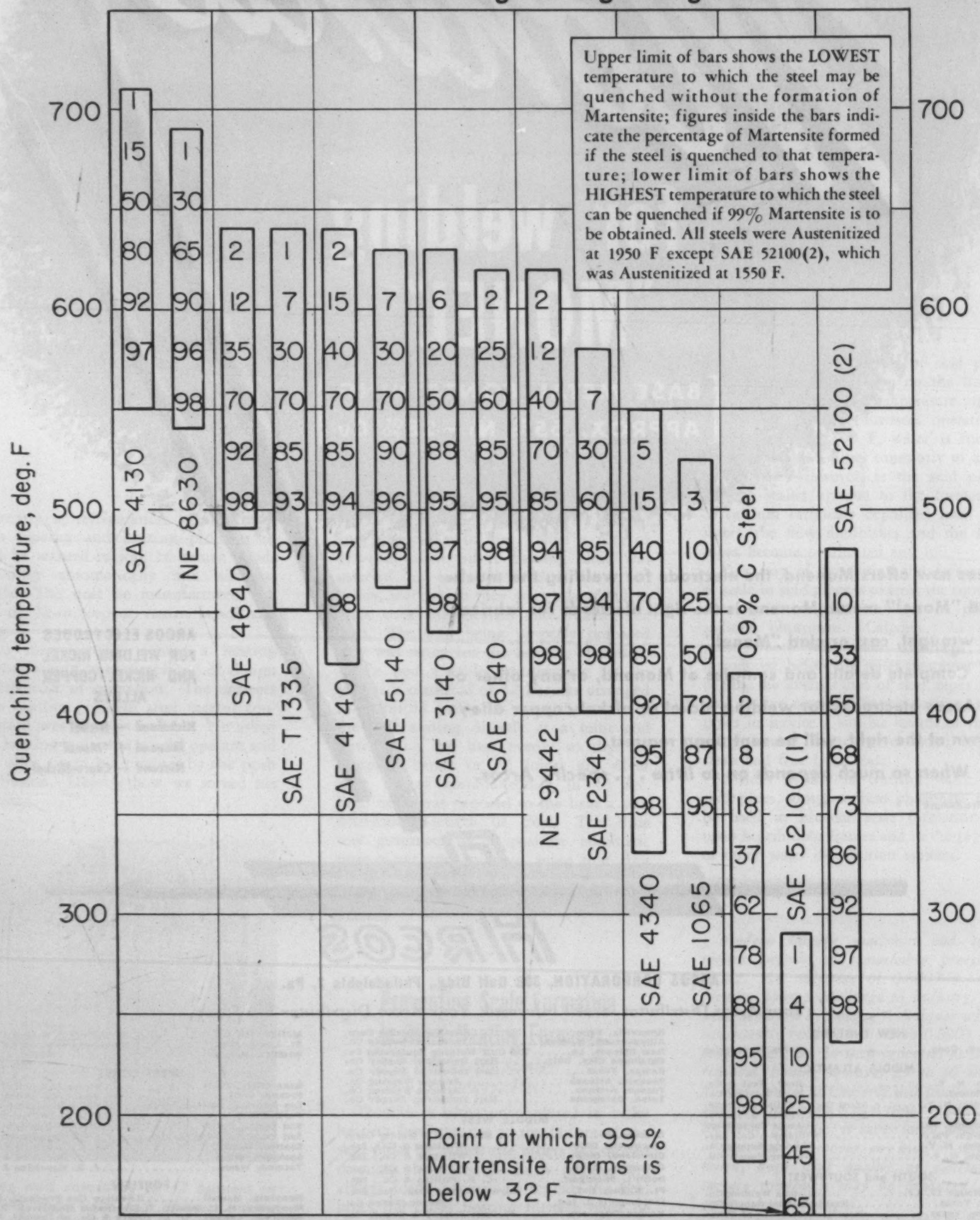
MATERIALS & METHODS **Engineering File Facts**

NUMBER 116
June, 1946

MATERIALS: Steel
METHODS: Heat Treatment

Martensite Formation Range for Engineering Steels

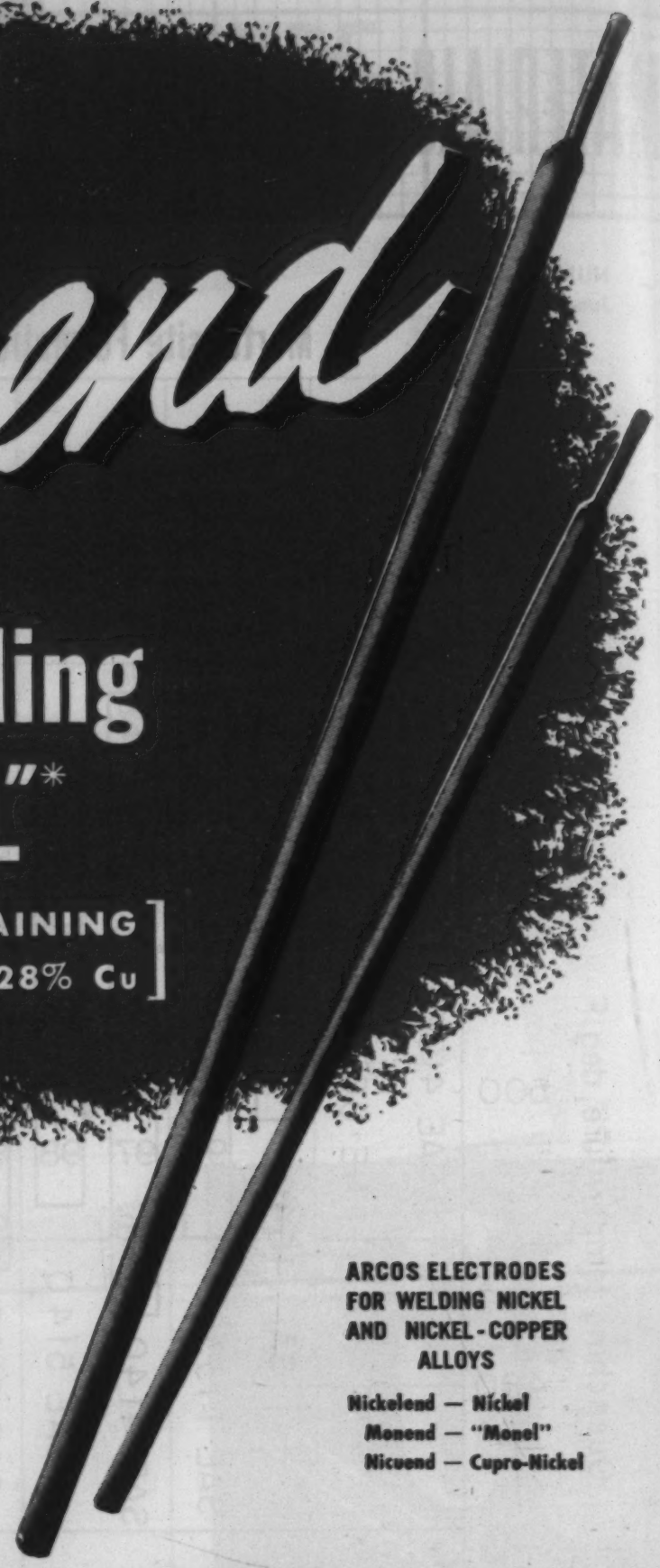


Adapted from a paper presented at AIME annual meeting, 1946, by Grange & Stewart, U. S. Steel Corp.

ARCOS Monend

for welding "MONEL"*

[BASE METAL CONTAINING APPROX. 65% Ni — 28% Cu]



Arcos *now* offers Monend, the electrode for welding the much-used "Monel" metal. Monend is the right electrode for fabricating wrought, cast or clad "Monel".

Complete details and samples of Monend, or any other of the Arcos electrodes for welding nickel or nickel-copper alloys shown at the right, will be sent upon request.

When so much depends on so little . . . specify Arcos.

ARCOS ELECTRODES FOR WELDING NICKEL AND NICKEL-COPPER ALLOYS

Nickelend — Nickel
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MIDDLE ATLANTIC

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Erie, Penna. — Boyd Welding Co.
New York, N. Y. — Arcos Corp., Phila. 2, Penna.
New Jersey — Arcos Corp., Phila. 2, Penna.
Philadelphia, Pa. — Arcos Corporation
Pittsburgh, Pa. — Williams & Co., Inc.
Rochester, N. Y. — Welding Supply Co.
Syracuse, N. Y. — Welding Supply Co.

SOUTH and SOUTHWEST

Baton Rouge 17, La. — Louisiana Welding Co.
Borger, Texas — Hart Industrial Supply Co.
Houston, Texas — Champion Rivet Co. of Texas
Kingsport, Tenn. — Slip-Not Belting Corp.
Knoxville, Tenn. — Slip-Not Belting Corp.
Albuquerque, N. Mex. — Industrial Supply Co.
New Orleans, La. — The Gulf Welding Equipment Co.
Oklahoma City, Okla. — Hart Industrial Supply Co.
Pampa, Texas — Hart Industrial Supply Co.
Phoenix, Arizona — Arizona Welding Co.
Tucson, Arizona — Arizona Welding Co.
Tulsa, Oklahoma — Hart Industrial Supply Co.

MIDDLE WEST

Chicago, Ill. — Machinery & Welder Corp.
Cincinnati, Ohio — Williams & Co., Inc.
Cleveland, Ohio — Williams & Co., Inc.
Columbus, Ohio — Williams & Co., Inc.
Detroit, Michigan — C. E. Philips & Co., Inc.
Ft. Wayne, Ind. — Wayne Welding Sup. Co., Inc.
Indianapolis 2, Ind. — Sutton-Garten Co.
Kansas City, Mo. — Welders Supply & Repair Co.
Milwaukee, Wis. — Machinery & Welder Corp.
Moline, Ill. — Machinery & Welder Corp.
St. Louis, Mo. — Machinery & Welder Corp.
Wichita, Kansas — Watkins, Inc.

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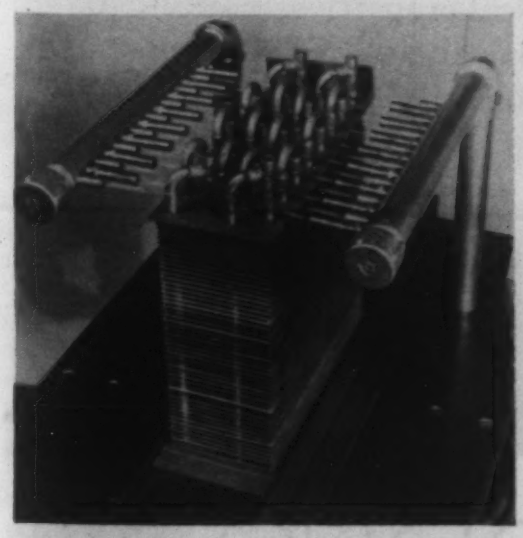
engineering SHOP NOTES

Automatic Brazing Unit for Refrigerator and Air Conditioning Coils

by Al Behrend,
Charles W. Krieg Co.

Recently a refrigeration manufacturer had a heating and brazing problem in which he wanted to join 16 return bends to tubing automatically and simultaneously. The unit he manufactured was made of 3/8-in. copper return bends and tubing.

This manufacturer wanted a heating unit that would have simplicity of design and low cost of operation. The answers to his heating problem after careful consideration was city gas and air. He asked for a heating unit that would operate and silver alloy braze his product by the push of a button. Here is how we solved his problem.



Brazing unit consisting of 32 burners in manifold style with each burner aiming directly at a joint.

The return bends were properly cleaned and prepared with flux. Then a ring of 3/64-in. diam. silver brazing alloy was inserted into each open end of the return bends, afer which they were assembled in place over the cleaned and fluxed tube ends. The unit being properly prepared now was ready for the heating operation.

We had a table arrangement set up so that it consisted of 32 burners arranged in manifold style, 16 on either side of the unit aiming directly at a joint and distributing the heat evenly so that 16 complete bends or 32 joints are silver alloy brazed simultaneously in 45 sec. Each bend was exposed to the heat a predetermined length of time. The time was governed by a positive automatic reset timer and solenoid valve that shut off the main gas supply, leaving a pilot burning after the unit had been properly brazed.

Preventing Scale Formation in Billet Heating Furnaces

by Harry Stanley,
Calgon, Inc.

Trouble is often encountered in billet heating furnaces due to the failure of the skid pipes on which the billets are shoved through the furnace. Such failures are always costly because to replace the skid pipes the billet heating furnace must be shut down, thus interrupting production.

One of the chief causes of skid pipe failures is scale formation on the inside of the pipes. Since the temperature under which billet heating furnaces operate is usually around 2100 F, water is forced through the skid pipes constantly to keep them cool. However, as the skid pipes become scaled up due to the formation of calcium carbonate deposited from the water, the flow diminishes and the skid pipes become overheated and fail.

One way of preventing the formation of scale in skid pipes is to treat the cooling water with minute amounts of glossy sodium phosphate (Calgon). In one plant where this water treatment was introduced, before the water treatment was begun, the average life of skid pipes was four to five months. In comparison, skid pipes in service a similar length of time, using treated water, were found to be clean and free from scale.

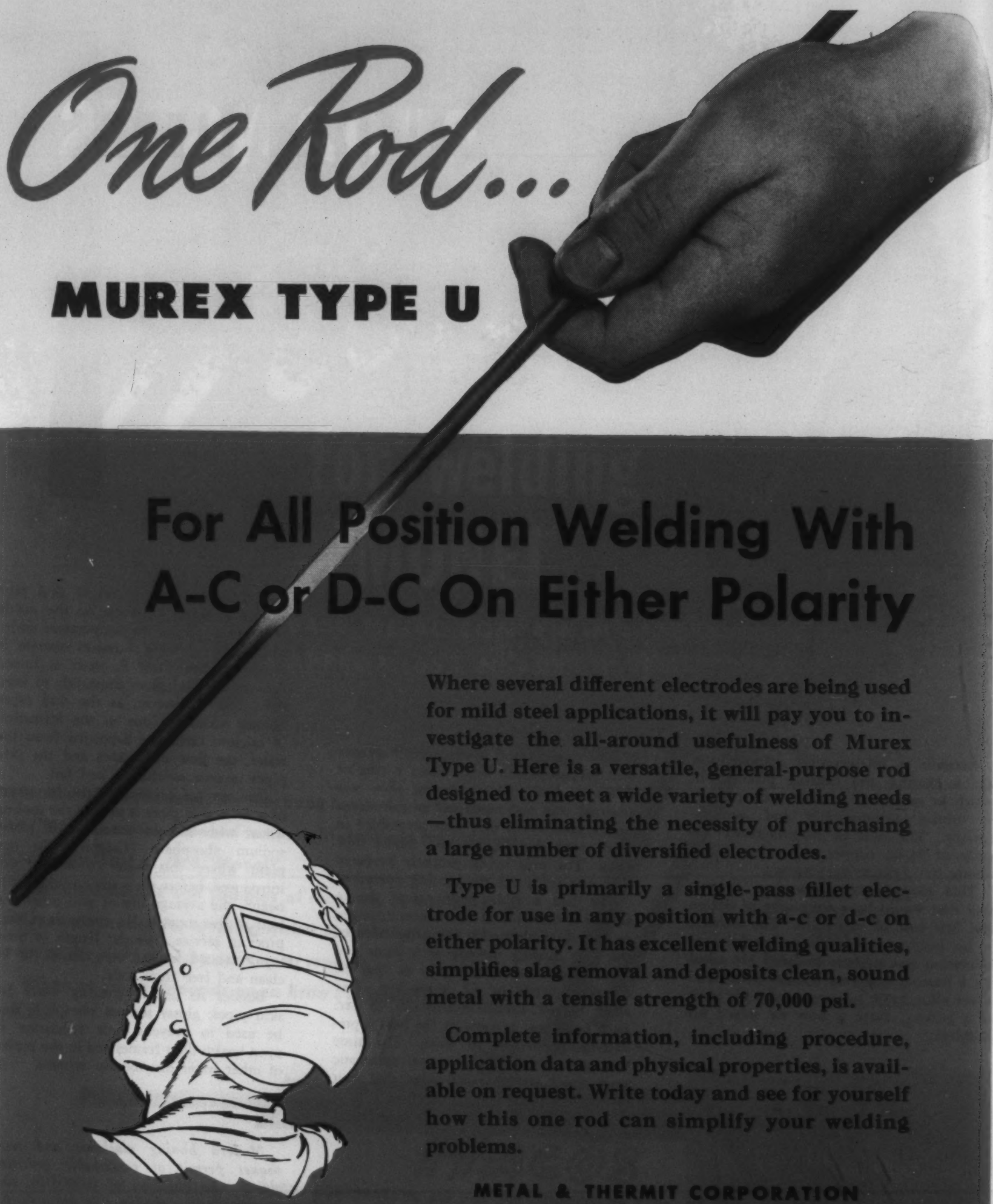
Besides its use in treating water for skid pipes, glossy sodium phosphate may be used to prevent scale formation in open hearth door frames and in the piping of other water distribution systems.

Modern honing machines and techniques permit of remarkable precision sizing. An objective of 0.0005-in. uniformity, long a challenge to industry, has been achieved by honing techniques which consistently hold operations to 0.0003 and even 0.0002 in. In such processes as stock removal, honing removes 25 to 30 times as much metal as formerly was practicable, and does the work 6 to 8 times faster than formerly possible. It saves large amounts of material. Moreover, any kind of surface finish, bore wall quality or controlled surface roughness may be produced and accurately reproduced.

—L. S. Martz & Douglas T. Peden, Micromatic Hone Corp.

One Rod...

MUREX TYPE U



For All Position Welding With A-C or D-C On Either Polarity

Where several different electrodes are being used for mild steel applications, it will pay you to investigate the all-around usefulness of Murex Type U. Here is a versatile, general-purpose rod designed to meet a wide variety of welding needs—thus eliminating the necessity of purchasing a large number of diversified electrodes.

Type U is primarily a single-pass fillet electrode for use in any position with a-c or d-c on either polarity. It has excellent welding qualities, simplifies slag removal and deposits clean, sound metal with a tensile strength of 70,000 psi.

Complete information, including procedure, application data and physical properties, is available on request. Write today and see for yourself how this one rod can simplify your welding problems.

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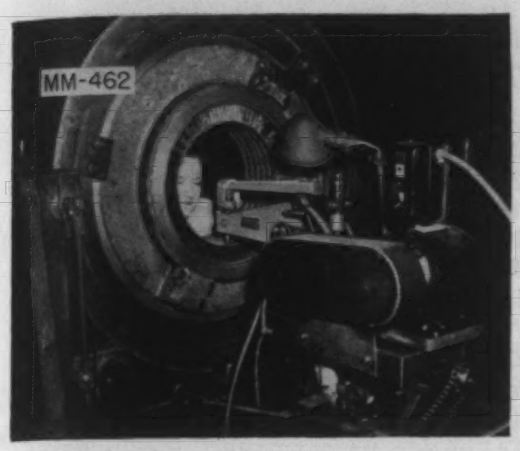
MUREX ELECTRODES

Blade Riveting Machine

by Lester G. Godlove, Westinghouse Electric Corp.

The old method of assembling shroud strips in turbine blade rings, in which the riveting operation was done by hand, has been susperseded by a riveting machine designed and built for this operation at the Philadelphia plant of Westinghouse Electric Corp.

This machine consists of a stand which holds the blade rings and a special riveting head. Mounted in the stand, on roller bearings, is a holding ring which holds the turbine blade ring in position under the riveting head. There are holding rings for the various sizes of blade



The riveting machine in operation on a turbine blade ring.

rings; each has the same outside diameter and width being supported on roller bearings fixed in the stand. After the blade ring is set up, a hand lever is used to position each rivet under the riveting pein.

The special riveting machine head is mounted at the rear of the machine but is adjusted horizontally and vertically from the operator's working position. It is adjustable vertically for positioning the pein to the different rows of blades in each ring.

Strength of Bond an Important Factor in Grinding Wheels

by H. H. LaVercombe, Abrasive Engineering Corp.

A grinding wheel is composed of two elements—the abrasive grain and the cement or bonding substance which holds the grain together in the form of a grinding wheel. The strength of the bonding substance is an important factor to be considered for most efficient operation of a grinding wheel.

The bonding substance should have strength to hold the grain in place only as long as the abrasive grains remain sharp enough to cut as they should. When the grains become dulled, the bond should break down and release the dull grains. In this way new and sharp grains come to the surface and, in turn, perform their portion of the grinding operation.

The required strength of the bond of a grinding wheel varies greatly according to the condition under which the grinding wheel is being used. The strength of bond required to hold a grain in place on a grinding wheel of 4 in. diam. would be entirely too strong for holding the same size grain on a grinding wheel of 12 in. or perhaps 40 in. in diam. For as the diameter of a grinding wheel increases, the circle forming the periphery approaches a straight line, and the grain is supported much more firmly on a large diameter than it is on a small diameter grinding wheel.

These same variations occur with different diameters of work being ground. The attack on a grinding wheel by a piece of work having a small diameter varies greatly from that of a piece of work having a large diameter. In addition to these, the rigidity of the grinding machine itself, the amount of metal or stock being removed, the material being ground, the surface required, the wheel speed in feet per min., the work feed all tend to alter the action of the grinding wheel.

It is evident from above that a grinding wheel should be carefully selected for each particular job. The proper strength of bond required should be determined; a reasonable limit of tolerance for this strength of bond should be established for each grinding operation.

To aid in the proper selection of wheels, an instrument, known as the Grade-O-Meter, can be used. All grinding wheels have labels indicating the grade or strength of bond; but these gradings generally vary and are not reliable. The Grade-O-Meter determines the true grade, or hardness, in mathematical units. It operates similar to hardness testing devices on steel. It will grade any wheel of diameter up to and including 6 in. in thickness.

This particular instrument has been designed for use in grinding departments for the purpose of determining the proper grade of grinding wheel for each operation.

Jig for Drilling Steel Balls

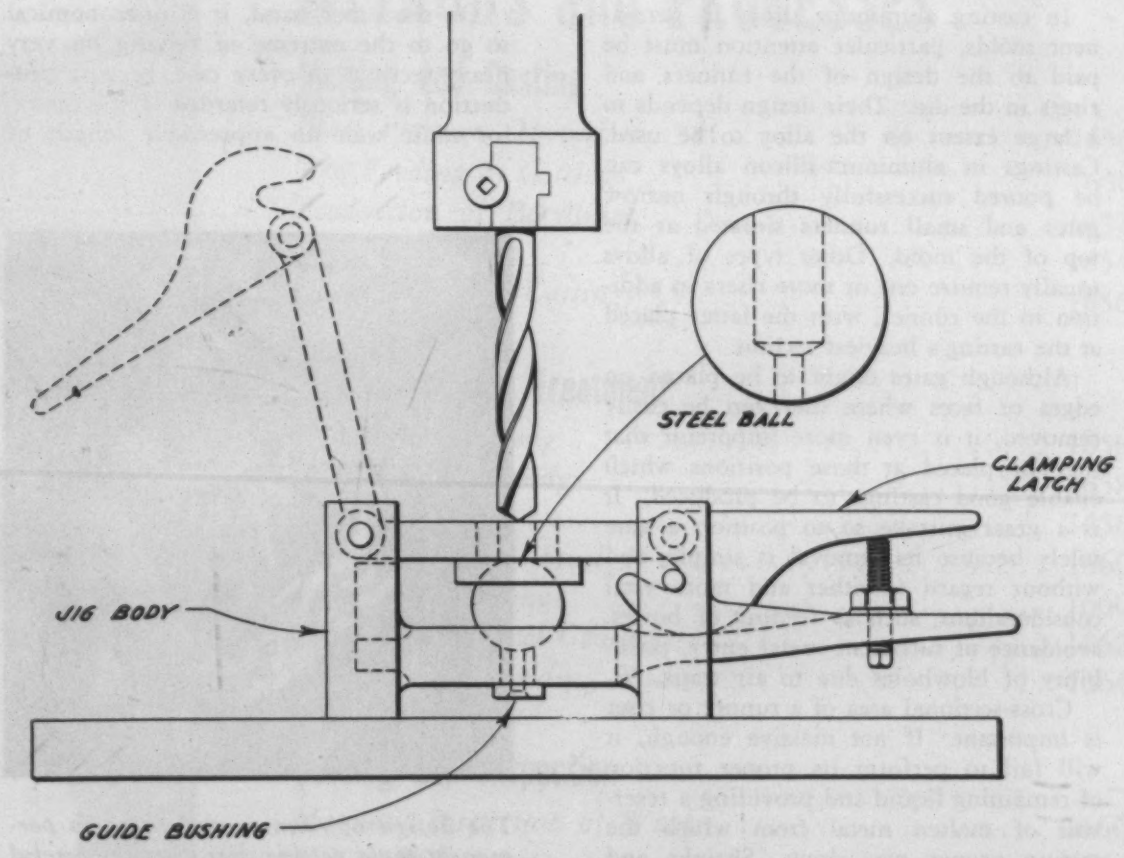
by Thomas A. Dickinson

One of the most irksome problems in many plants is the matter of drilling holes in small steel balls. The accompanying drawing shows how this has been accomplished by means of a very simple box-type drill jig at Consolidated Vultee Aircraft Corp., Downey, Calif.

The purpose of the jig is to provide two bushings and two indented surfaces, which will simultaneously guide the drill and hold the steel ball in a suitable position. The indented surfaces are faced with thin strips of rubber in order to keep the ball from slipping while drilling takes place; the bushings are situated over and below the indented surfaces.

The upper bushing is mounted in a leaf, which can be fastened down over the ball by means of a simple clamping latch; its inside dimensions are slightly greater than the diameter of the drill that is to be used. The lower bushing is a guide bushing, and its purpose is to regulate the depth of the drilling operation. It is situated in a fixed base member.

Because the jig would not normally have to withstand great stresses, most of its parts could be made of wood if necessary. Also, if the leaf were adjustable as well as movable, and if the bushings were of the slip type, the tool could be used in drilling balls of a variety of sizes.



Side view of drill jig used in drilling holes in small steel balls.

Air-Cooled Salt Baths for Interrupted Quenching

by H. W. Schramm,
Surface Combustion Corp.

Interrupted quenching in the heat treatment of metal parts has come into wide use during recent years because of its many advantages over the conventional quenching methods. The process of interrupted quenching reduces the temperature difference between the core to case and thus lowers internal stresses that result in micro cracks, surface cracks, warpage, breakage and other similar causes of rejection.

When performing interrupted quenching in salt baths, it is often desirable from the standpoint of efficient and steady production to cool the quenching medium by circulating air around the pot. By this means, during quenching, a considerable quantity of heat is removed by the air which is allowed to flow through the burner equipment and pot setting. Thus, the desired temperature of the salt bath is maintained. This materially increases the quenching capacity of the pots when compared with that obtainable without air-cooling.

Temperature control may be accomplished by controlling the gas off and on and allowing the full amount of air to flow through the burners continuously. When the gas is on, the air aids in heating; when the gas is off it cools the pot. A somewhat more efficient control is to operate the burners off and on at the control point, turning on the air only for cooling, slightly above the control point.

The accompanying table shows the quenching capacity for various salt bath pot sizes manufactured by Surface Combustion Corp. with and without air-cooling and with burner pilots operating.

	Quenching Rate — Pounds of Steel per Hour					
	From 1600 to 500 F		From 1600 to 600 F		From 1600 to 800 F	
Pot Volume (Cu. Ft.)	No Air Cooling	Air Cooling	No Air Cooling	Air Cooling	No Air Cooling	Air Cooling
0.66	5	13	7	19	15	38
1.00	6	18	9	26	18	50
1.30	8	24	12	36	24	68
2.25	10	29	15	43	30	97
2.20	9	32	14	46	27	87
4.00	14	36	21	53	42	105
2.80	15	39	23	57	45	110
3.00	14	43	21	60	42	120
3.37	11	43	17	63	33	140
3.37	14	43	21	63	42	140
5.00	17	49	26	73	51	160
5.10	16	55	24	81	48	180
5.50	22	64	33	93	66	200
11.30	27	81	41	120	81	275
11.00	26	100	39	145	78	320

Permanent Mold Casting of Aluminum Alloys — Tips on Gates and Risers

by Samuel Frankel,
Foundry Services, Inc.

In casting aluminum alloys in permanent molds, particular attention must be paid to the design of the runners and risers in the die. Their design depends to a large extent on the alloy to be used. Castings in aluminum-silicon alloys can be poured successfully through narrow gates and small runners situated at the top of the mold. Other types of alloys usually require one or more risers in addition to the runner, with the latter placed at the casting's heaviest section.

Although gates ought to be placed on edges or faces where they can be easily removed, it is even more important that they be placed at those positions which enable good castings to be produced. It is a great mistake so to position a gate solely because its removal is simple, and without regard to other and more vital considerations, such as feeding of bosses, avoidance of turbulent metal entry, possibility of blowholes due to air traps, etc.

Cross-sectional area of a runner or riser is important. If not massive enough, it will fail to perform its proper function of remaining liquid and providing a reservoir of molten metal from which the casting proper may draw. Shrinks and cracks will result.

On the other hand, it is uneconomical to go to the extreme of relying on very heavy sections in every case, because production is seriously retarded if the operator must wait an appreciable length of time after each cast before the mold can be opened.

It is good practice to start off with runners, etc., rather smaller than one's experience or judgment deems advisable, then increase gradually after a few trials until they prove just large enough to produce the desired results.

—Courtesy of "Fluxuations"

The design of runners and risers in permanent mold casting dies requires careful consideration.

Here is a solution to fine dust problems that should prove of value to many industries. Hagan Corp., combustion engineers, reports development by a southern engineer of a new feature for combustion control regulators to meet conditions where fine dust in the air stops up the regulator mechanism. The engineer not only enclosed the regulator in a box to keep out the fine dust, but ran in a compressed air line and kept a little positive air pressure in the box, thus insuring that the regulator stay clean. It has proved most satisfactory.

—News release from Hagan Corp.

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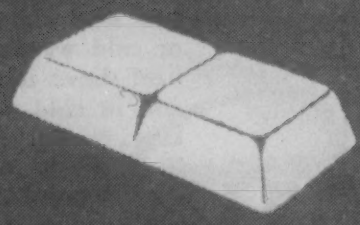

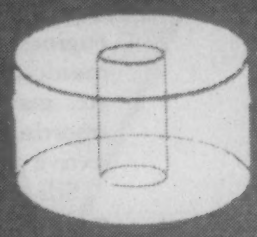

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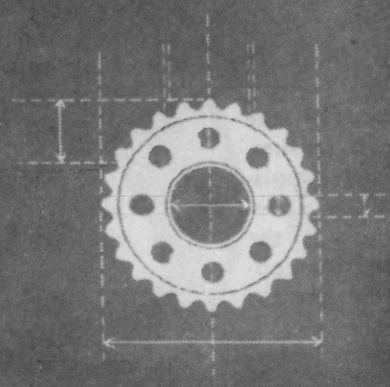

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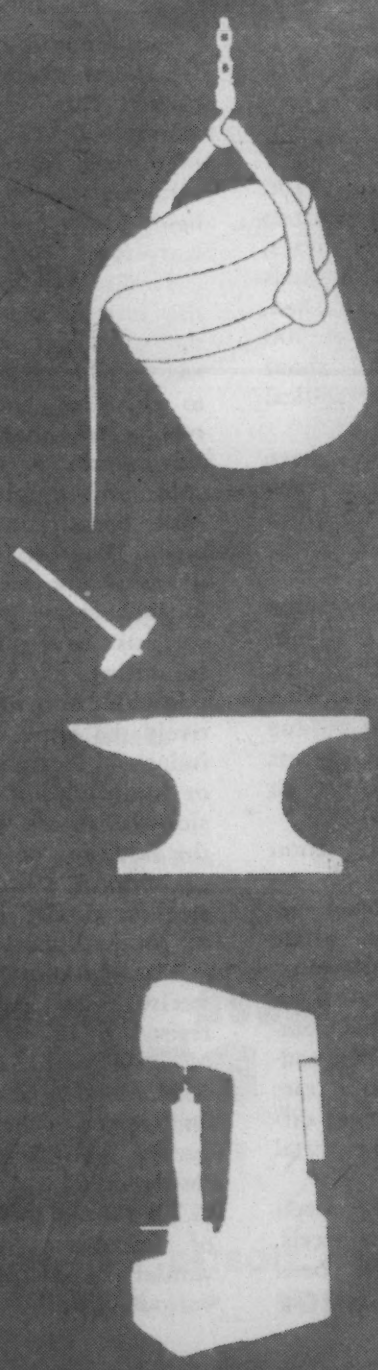

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METALS and ALLOYS

Engineering properties and applications of carbon, alloy and stainless steels, irons and nonferrous metals and alloys. Selection and evaluation of metallic materials for engineering service. New alloys and modifications.

Nonferrous Metallurgical Research at Frankford Arsenal

Condensed from "Journal of Applied Physics"

The Frankford Arsenal—the Nonferrous Research Center of the Ordnance Dept.—maintains, in times of peace, up-to-date production facilities operating continuously. At the outbreak of an emergency requiring enormous quantities of material, the experience and procedures are made available to industry and the Arsenal functions as a control and advisory center.

The Laboratory Division is organized to handle nonferrous metallurgical problems of any type concerned with functioning of Ordnance material. A Nonferrous Metallurgical Advisory Board consisting of 17 representatives of the Army, Navy, universities and industry, reviews data, reports and specifications. The facilities of the Arsenal are supplemented by contacts with universities and industry.

The largest field of nonferrous research is that of copper and copper-base alloys. One of the most serious problems involved in the storage of ammunition has been season cracking of the brass. Of the preventive practices employed, the stress relief anneal and the mouth anneal of the cartridge case have been most beneficial. The mechanism of season cracking has not been definitely established.

In a program of investigation, the mercurious nitrate test was standardized. An investigation of the sources of corrosion atmospheres indicated that smokeless powder is a major source of corrosive agents. Experimental work in measuring residual stress in cartridge cases by the X-ray diffraction method is being done at Lehigh University in cooperation with the Arsenal.

The shortage of brass necessitated the reworking of fired cases. Equipment for carrying out a damping capacity test at a large stress amplitude permits detection of side corrosion cracks deep enough to give rise to splitting in firing.

The Frankford Arsenal is assembling information on light alloys to meet the demand for greater mobility of equipment. Weight saving can be effected by the use of aluminum alloy cartridge cases and primer components for ammunition. Aluminum alloys are being investigated for use in body armor and for protection of aircraft structures. The use of aluminum alloys in permanent mold or sand castings for fire control instruments has been developed. Recommendations have been made for aluminum and magnesium alloys in rocket launchers and fuze parts.

Among the studies undertaken by the Arsenal are that of synthetic resin finishes, protective coatings for zinc surfaces, moisture and fungus proofing of material, precision casting of nonferrous metals, the substitution of a non-critical steel for copper and zinc, and the use of new low tin solders.

—C. H. Greenall. *J. Applied Physics*, Vol. 16, Dec. 1945, pp. 787-792.

Corrosion Developments

Condensed from "Iron and Steel Engineer"

During the past ten years over 3500 papers have been published on various subjects pertaining to corrosion, its causes, control, etc. and, in addition, many hundreds presented at meetings but not published. In gathering facts for this paper, over 500 papers have been abstracted and about 100 of these are listed in the bibliographical reference as an addenda.

The most interesting developments have been with the application of sodium hexameta phosphates, cathodic protection, silica gel, and the combination use of phosphates and sodium silicates.

From studies made it is apparent that the matter of corrosion can be divided into three groups, namely: (1) Corrosion due to atmospheric conditions; (2) Corrosion due to water conditions; (3) Corrosion due to soil conditions. This paper comments mostly on item No. 2, corrosion due to water conditions.

The most important factors are the action of oxygen and carbon dioxide mainly on the interior surfaces of water or steam distribution systems. Corrosion occurs where ferrous metals come in contact with water, the main factors being free oxygen or oxidizing agents, metal surface films, temperature, composition of the solution, contact effects between dissimilar metals, rate of motion, and other factors effecting diffusion through the solution to the metal surface.

In water, salt or fresh, low alloy steels have little advantage over carbon steels, and practically no difference has been found in various commercial types of carbon steel and wrought iron in either hot or cold water. Three per cent chromium steel shows less tendency toward corrosion, and in cold water where surfaces can be kept reasonably clean, 18:8 steel shows little effects of corrosion.

Moisture corrosion of metal parts will not take place if the relative humidity of the surrounding air is less than 30%. Consequently, if a very dry air can be assured, machined parts such as aircraft engines, instruments, rifles, generators, communication equipment, automotive parts, etc. may be preserved indefinitely without resorting to heavy grease coatings or protective paints.

Silica gel has the property of absorbing moisture from the air, even at low humidities. Some silica gel is colored with cobalt salts to give a visual indication of its condition. This type is blue at maximum efficiency and fades to a light pink as its absorbing capacity decreases. When pink or red it can be heated to drive out the moisture and then used over again.

—H. M. Olson. *Iron & Steel Engr.*, Vol. 23, Jan. 1946, pp. 80-95.

Study of Corrosion

Condensed from a Paper of the American Society for Metals

Atmospheric corrosion rates for identical specimens of iron vary with local atmospheric conditions; moisture (both the amount of time the specimen is moist and the water content of the air) and such contaminants as sulphur dioxide and salt being the most potent factors in effecting corrosion.

Under the same atmospheric conditions the rate of corrosion is dependent upon the composition of the material. Also, it has been found that the over-all resistance to corrosion depends a great deal upon the type of rust that is formed during the first six months to a year of exposure. The color and roughness of the scale or rust have been found to be indicators of its type. The rust formed in a marine atmosphere is not as protective as that formed in the average industrial environment.

Tests have shown that the corrosion inhibiting effect imparted to steels by a particular alloying element is not quantitatively the same at both marine and inland industrial locations. Steels containing 0.5% or more chromium may have their corrosion resistance increased considerably by the addition of small amounts of copper, phosphorus, silicon or nickel, provided the steel originally has low residual amounts of copper, phosphorus, silicon and nickel.

The chromium-silicon-copper-phosphorus steels showed definitely superior corrosion resistance in tests conducted at Kearny, N. J. and South Bend, Ind. over nickel-copper-molybdenum-phosphorus steels. Nickel and copper in the presence of other alloying agents furnish about equal amounts of resistance to rusting.

The range of variation in the amount of corrosion among steels essentially similar in composition when exposed to various types of weather or atmospheres

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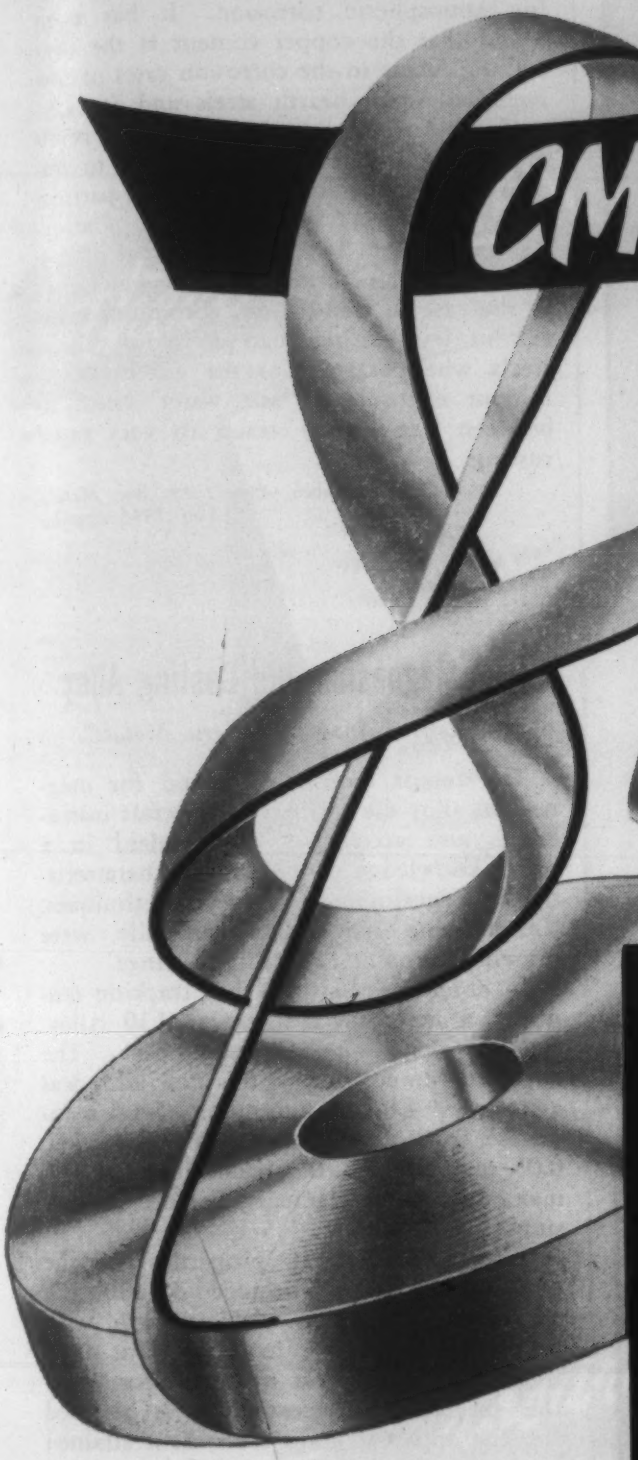

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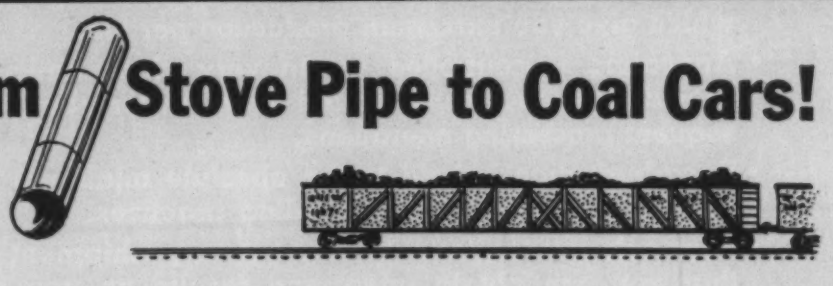

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indicate the multiplicity of factors influencing atmospheric corrosion. It has been found that the copper content is the controlling factor in the corrosion rates of low metalloid open hearth steels and irons.

Tests in fresh water indicate that a minimum of 2% chromium is needed to improve the corrosion resistance of a particular sample 50%. Small amounts of alloying agents seem to have little effect on the resistance to corrosion in fresh water. As in the case in fresh water, chromium steels exhibit less rusting than do plain carbon steels when exposed to sea water. Intermittant exposure to salt water (such as between tide levels) result in very rapid rusting.

—C. P. Larrabee. Paper, *Am. Soc. Metals*, Feb. 1946 meeting.

New Magnesium Die Casting Alloy

Condensed from "Modern Metals"

The recent increased demand for magnesium alloy die castings for aircraft instruments and accessories has resulted in a better knowledge of the casting characteristics and development of special techniques. Troublesome hot cracks generally were present in commercial alloy castings.

In order to lessen this hot cracking tendency, a new alloy, Eclipsaloy 130 Alloy, was developed by Eclipse-Pioneer. The chemical composition of this new alloy was as follows: 1.0-1.5 aluminum, 0.5-1.5 manganese, 0.005 max. iron, 0.005 max. nickel, 0.05 max. copper, 0.3 max. silicon, 0.3% max. total other elements, balance magnesium.

Typical mechanical properties of the heat treated alloy included 32,000 psi. tensile and 21,000 psi. yield strength, with an elongation of 9% in 2 in. This alloy requires a special heat treatment for desirable mechanical properties. It is believed that the apparent grain refinement attained in heat treatment is the result of precipitation of the aluminum-magnesium intermetallic chemical compound.

Extensive investigation of the corrosion resistance of this alloy reveals that in the untreated, chrome-pickled, and dichromate treated conditions it has a comparable corrosion resistance to the most corrosion resistant die casting alloys in use at present.

The casting characteristics of the new alloy differ from those of other magnesium die casting alloys in the following respects: (1) Less tendency towards hot cracking; (2) lower apparent fluidity; (3) greater tendency towards apparent internal shrinkage porosity; (4) greater tendency towards flow marks on the surface of the casting; and (5) less tendency towards soldering to the die.

It was found that the amount of shrinkage porosity present in magnesium die castings is influenced by alloy composition as well as by casting technique.

Owing to the large gates required for castings of this new alloy, it is sometimes necessary to remove the gates from castings by sawing rather than by the use of trimming dies or by breaking off by hand.

—R. F. Hauser. *Modern Metals*, Vol. 2, Mar. 1946, pp. 8-10.

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NONMETALLIC MATERIALS

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Plastic Rotors for Fords

Condensed from "Modern Industrial Press"

Precision operations, with one dimension held to two ten-thousandth of an in., are applied to plastics parts at the River Rouge plant of the Ford Motor Co. at Dearborn, Mich. One such part is the distributor rotor, which is molded from a plastic material and weighs a trifle under an ounce.

In outline it resembles a blunted wedge with a rounded top and is 1-5/16 in. across at its widest dimension and 2⅛ in. at greatest length. Its greatest thickness is 1 in., and it is reinforced at points where operational stresses are most severe.

One side of the rotor is smooth save for a ⅞-in. collar, which rises ¼-in. above the surface and in the center of which is an accurately molded circular cavity, flat on one side to insure a solid fit on the distributor shaft when the rotor is assembled. The other side of the rotor has a slightly larger circular collar with an opening cut in the circumference to permit assembly of a steel spring and brass tongue, which will be assembled later.

Precise tolerances are maintained through careful press operation plus exact calculation of the amount of shrinkage on cooling. Rigid controls in weighing raw materials and in time and temperature factors insure a steady, uninterrupted flow of completed rotors.

Powdered plastic raw material is first preformed into rectangular pellets, weighing slightly less than an ounce, by hopper feeding into a preform press. The pellets are set aside to season for 24 hr. at 110 F. The rotors are then molded on an automatic 300-ton Lake Erie press with a 35 cavity mold.

Prior to molding, the preforms are placed in an infra-red oven and preheated for 3 min. at 180 F. While heating, a small steel rivet is inserted into each cavity. Now the pellets are removed from the oven and one placed in each mold cavity.

Once the cavities are loaded, the operation of the press becomes automatic. The top platen of the press is stationary, the bottom one rising.

A timer regulates the period that the press remains closed, and a thermostat holds the electric heat within a 4-deg. limit. The rotor is held for 5 min. at 300 F, and the press opens to its full width and the operator removes the flash and the formed parts. While some flash or excess material is necessary to insure complete filling, too much excess means molding distortion and waste.

A control panel shows the various cycles, times and temperatures at a glance. In the assembly operations, a flat steel spring with a hole punched in it to permit fitting over the embedded rivet and a brass tongue, similarly drilled, are fitted into place.

In punching a hole in the steel spring, two light perforations were made at each side of the hole and as the rivet is spun shut these sharp "nicks" are pressed firmly into the body of the plastic part for better anchorage.

—*Mod. Ind. Press*, Vol. 8, Mar. 1946, pp. 38, 39, 42.

Wood Finishes

Condensed from "Mechanical Engineering"

The lacquer industry became a specialized arm of the chemical industry after the first World War when laboratories were set up for research on nitrocellulose lacquer. Under the du Pont lacquer license, which expired in 1944, effort was concentrated on making lacquer products better instead of cheaper.

The basic components of a lacquer film are: nitrocellulose, resin and plasticizer. Early good wood lacquers were deficient in humidity or moisture-check resistance. Studies revealed that this could be solved through the use of synthetic resins of the so-called alkyd type.

There is reason to believe this development will now be pursued further. The advent of the alkyd resin also provided a means of sealing wood successfully.

Another fundamental development was that of a non-grain-raising or permanent stain in which the dyes are dissolved in a mixture of desirable organic solvents instead of water. Techniques have been developed which make it possible to finish widely varying wood surfaces.

Development work on a combination stain and filler, employing the non-grain-raising stain as its base, seems headed for wide exploitation in the future. The subject of wood filler has been the most neglected of all finishing product development, and the new and proposed types of peacetime finishes cannot be used over the present orthodox type of oil-paste wood filler.

One development that will make an early appearance in production has no filler problem. This is the reproduction of beautiful grain effects on inexpensive close-grained woods. This is done by graining from plates made from photographs of unusual and selected wood flitches.

Other peacetime developments will include both air-dry and baking finishes. The two outstanding characteristics of these clear finishes will be higher-than-lacquer solid contents or film thickness, and improved film resistance. All will adapt themselves to short finishing schedules.

Development of the potential possibilities for improvement in lacquer depends on the interest of the consumer in quality. The ruggedness and resistance of the finishes developed in laboratories during the war makes them inviting. But their adaption for practical use is stymied until worthy undercoats, particularly fillers, are developed. The encouragement of the consumer in this development is vital.

—P. S. Kennedy. *Mech. Engineering*, Vol. 68, Mar. 1946, pp. 212-214.

Synthetic Diamonds

Condensed from "Industrial Diamond Review"

In spite of many investigations the synthesis of the diamond has not yet been solved, neither technically nor scientifically. The experiments of H. Moissan, a German, around 1900 are sometimes considered as a successful synthesis. In more recent years Moissan's experiments were examined and extended by improved means. However diamond synthesis could not be proved and his experiment could not be considered successful.

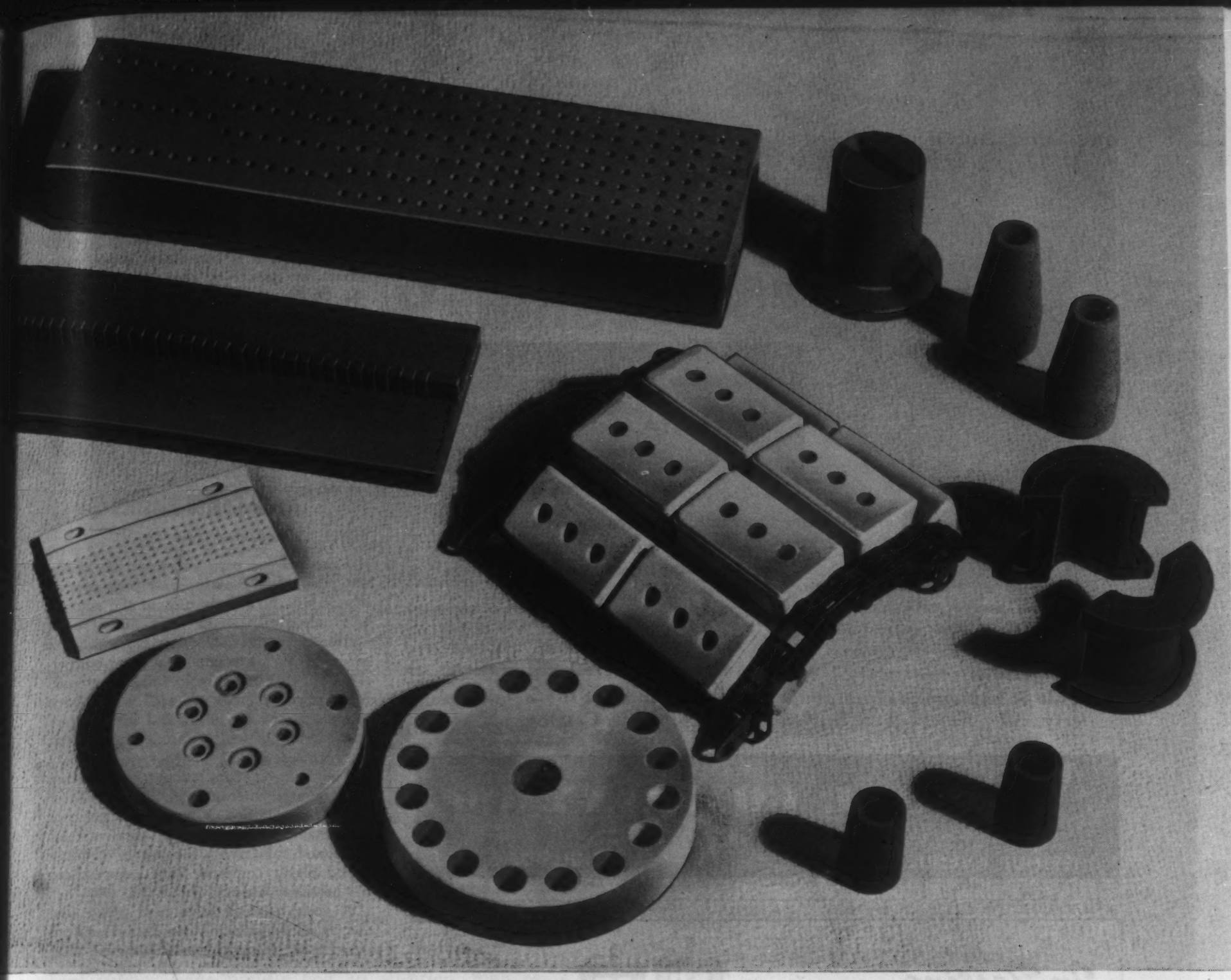
A special apparatus was developed allowing percussion pressures up to 1,070,000 psi. to be obtained for a short time. In this way pieces of graphite and carbon were compressed at very high temperatures. The direct transformation into a diamond still could not be achieved.

It seems doubtful to more recent experimenters that the synthetic product was ever produced in the first place. The conditions in nature for forming diamonds are not sufficiently known, as diamonds have usually been found in secondary deposits, but from the study of diamonds in their original matrix it has been possible to postulate theories of the formation.

Various experiments have been based on two principles: One, a diamond, being a high density allotropic modification of carbon, the transformation from graphite could be achieved by applying higher pressures. Two, when carbon in the gaseous, liquid or dissolved state is cooled rapidly, the unstable modification (the diamond) should separate first, according to Ostwald's phase rule. It is assumed that the relationship between graphite and the diamond is of monotropic nature. The diamond is the unstable modification of the higher density at ordinary pressure and at all temperatures.

Any experiment made with the object of obtaining diamonds by quick cooling of the gaseous or liquid phase cannot succeed. One set of experiments was conducted with iron melts saturated with carbon at high temperature and quick cooling of these melts in a manner allowing high pressure to be developed within them.

An electric arc furnace was combined



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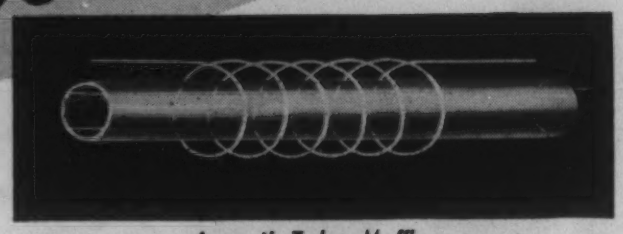

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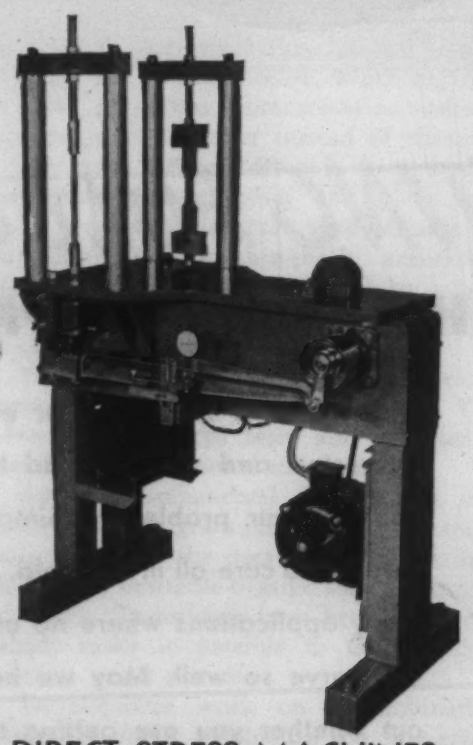

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with a Tamman furnace. Of 70 experiments, only 4 yielded a few minute crystals which might have been diamonds. However, the experiments could not be repeated and the synthesis cannot by any means be considered successful.

Therefore, if it possible to produce diamonds by quenching metal melts containing carbon, the diamonds would be very minute and not even useful as an abrasive. It is obvious that the growth of the nuclei developed is hardly possible because the velocity of diffusion of carbon becomes appreciably small with falling temperature.

—P. L. Guenther, P. Geselle & W. Rebentisch, *Ind. Diamond Rev.*, Vol. 6, Feb. 1946, pp. 42-46.

Metal Coated Plastics

Condensed from "Steel"

Plated plastic parts and materials having the outward appearance and properties of metals will find many uses in the automobile, electrical, aircraft, electronic, office equipment, tableware, jewelry, and other fields. They made important war contributions in electricity, radio, and electronics. Metal-plated plastics are used where intricate shapes of conductor and insulator are necessary or in which thin layers of metal are required.

The light-reflecting properties of metals have aroused interest in the production of mirrors on plastics. Where a metal surface is desirable for impact and abrasive resistance and reflectivity, the use of a metal-plated plastic combines both lightness and the necessary metallic properties.

A metal coating helps to dissipate heat and raises considerably the distortion temperature of plastics, especially where there is localized heating. It also increases the dimensional stability of plastics subjected to temperature changes below the distortion temperature, prevents localized overheating, and assures more rapid return to normal temperature.

By completely covering the plastic with a metal coating, absorption of water, oil and other solvents is greatly reduced or rendered nil, depending on the thickness of metal applied. The overall strength of a plastic may be increased 10 to 30% by plating.

The corrosion resistance of metals plated on plastics is superior to that of the same metal plated on a metallic base, because electrolytic potentials between dissimilar metals are eliminated. Plating contributes vibration resistance to plastics.

Metals may be applied to plastics by metal spraying, vacuum deposition, chemical reduction to yield a metal film, and electroplating. In the electroplating methods, the surface of the plastic must first be made conductive. This can be done by the application of waxes and then coating with graphite, or applying lacquers or varnishes containing metal powders, by chemical reaction to yield an electrically conducting compound, and by chemical reduction to yield a metallic film. Most of the proposed methods have proved to be unsatisfactory, or of limited application because of various reasons.

Metallizing by chemical reduction is the most widely used method, particularly as

Why Hard Rubber for *Knife Handles?*

The reasons why so many cutlery manufacturers use hard rubber may lead you to the solution of one of your design or production problems.

AMONG the advantages of these attractive hard rubber knife handles is their easy assembly into permanent units. Hard rubber has thermoplastic tendencies when heated through, but is a hard, strong solid at ordinary temperatures. Thus, the heat-softened rubber readily closes around metal inserts or cores—such as the tang of a knife or tool handle—and shrinks tightly to the metal as the assembly cools. Because rubber is a permanent plastic with good machining qualities, assembly by riveting also produces an enduring unit.

Hard rubber has a pleasant, sure feel in the hand of the user. It holds its shape in water because rubber is the most nearly waterproof of all the plastics. A hard rubber knife handle has, in addition, high resistance to alkalies and to hot soap solutions. It completely ignores the softening inroads of fats and oils.

So far none of the newer plastics has the overall properties needed for applications like this. However, since we have research and manufacturing facilities for both rubber and the other plastics, our laboratories test new developments in each. Thus, we are always in a position to give our customers better materials as they appear.

We manufacture an extensive line of hard rubber knife handles to meet the needs of cutlery manufacturers. Special designs can be made up and executed whenever volume warrants the design and mold costs.

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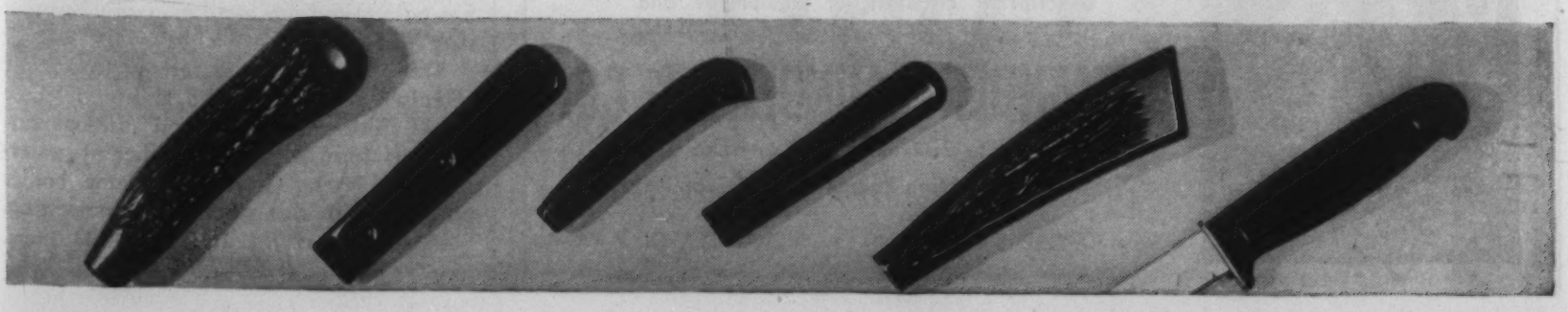

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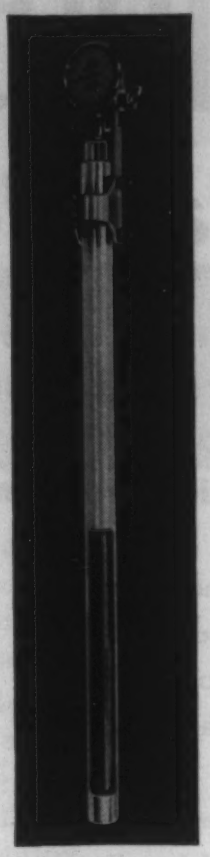

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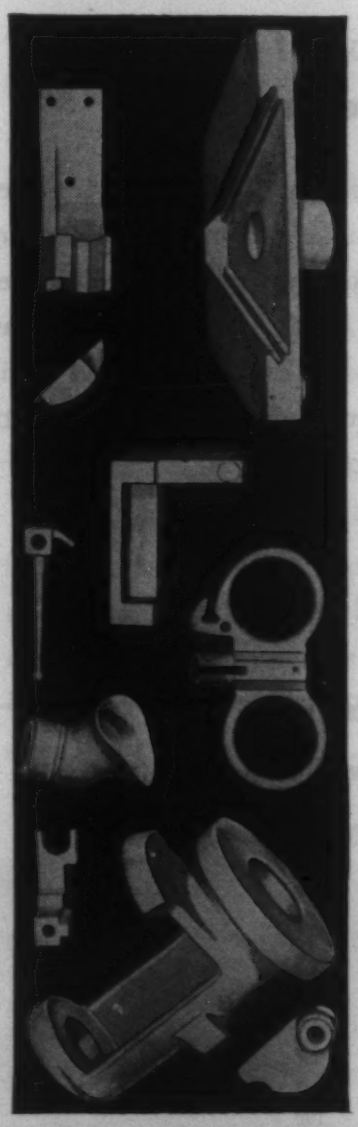

An OPEN LETTER on

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If you are now producing small metal parts by conventional methods of casting, forging or machining, you may be able to realize substantial savings in production costs by using precision casting methods.

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a conductive coat for subsequent electroplating. The latter follows standard practice with minor variations.

The pores of porous plastics must first be filled, if electroplating is to be successful. The most common method of improving adhesion is to roughen or swell the surface of the plastic. For maximum adhesion, the design should provide grooves, re-entrant curves, rounded projections, and minimum possible areas of flat smooth surfaces, and the interlayer should be stronger than at least one of the materials joined.

—*Steel*, Vol. 118, Feb. 18, 1946, pp. 92-95, 136-138.

Silicones

Condensed from "The Journal of the American Ceramic Society"

Silicones, like glass, result from the chemical modification of sand (or silica). Whereas glass results from fusing sand with other inorganic oxides, silicones are derived from sand by replacing some of the oxygen linkings with hydrocarbon groups.

An infinite number of silicones is possible, and several thousand have already been made, as the silicone chemist varies the organosiliconoxide building units to give just the right properties in the finished product.

Silicones derive many of their most useful properties from the inorganic nature of the silicon-to-oxygen links which they possess in common with glass and mineral silicates. They derive plasticity, solubility, and water repellency from the organic radicals attached to their basic structures.

The chemical nature of silicone in combination with oxygen permits the development of a variety of compounds in various physical forms ranging from fluids through gels and resins to elastic materials.

The silicone products, derived as they are from sand, comprise an entirely new group of engineering materials. Because of their ease of application, their general heat stability and inertness, they are natural complements to ceramic bodies in many applications. They are already proving their usefulness with these materials in the production of new types of electrical insulation, in the surface treatment of glass and ceramic products, and as auxiliary dielectrics for use with ceramic insulating forms.

Several families of liquid silicones have been prepared in which the basic structure is a long chain of alternate silicon and oxygen atoms which may be compared to the well-known series of paraffin hydrocarbons. In both types of fluids, the basic structure is a long chain, and oils of various viscosities result from varying the average chain lengths. The silicone fluids are much less volatile, have higher flash points and fire points, and are more oxidation-resistant than petroleum oils of equal viscosity.

The property of most interest to ceramic chemists, however, is the ability of these liquid silicones to adsorb on siliceous surfaces to form a strongly adherent water-repellent layer. Ceramic insulator bodies provided with this surface are nonwetting.

—Shailer L. Bass, J. F. Hyde & R. R. McGregor. *J. Am. Ceramic Soc.*, Vol. 29, Mar. 1, 1946, pp. 66-70.

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Operation Pluto

Condensed from "Transactions of the Institute of Welding"

Operation Pluto (Pipe Lines Under The Ocean) consisted in laying two types of pipeline under the English channel, the Hais cable and the Hamel pipeline. The latter consisted of 3-in. nominal diameter steel tubes electrically flash-welded together into the full length required for laying, this length being coiled around floating drums from which it was unwound and laid on the bed of the Channel. Through the lines were forced oil and gasoline for the Normandy invasion forces. This article deals only with the Hamel pipelines.

The laying of this pipeline at the bottom of the Channel (around 30 miles) had to be done in a single night. The pipe had to be bent to a relatively small radius, hence it would be stressed beyond its elastic limit, and any joint would have to withstand such treatment and subsequent restraightening. After some investigation it was decided to use flash welding as a means of joining the sections of pipe.

Tests showed that bending and straightening 6 times around a radius of 17½ ft. had no damaging effect on the tube or weld. Even down to a 4-ft. radius, bending and restraightening three times was not harmful. Work-hardening of the tube by bending proved not serious. Various heat treatments were given the welds, such as slow cooling, rapid cooling in air and water quenching, but these had but little effect.

Coiling tests at various speeds and loads showed no difficulty in coiling or uncoiling at speeds up to 10 ft. per sec., which were greater than those used in actual laying. For welding the 40-ft. lengths, a special tool was devised to remove the internal flash consisting of a long rotating bar having a cutter, brush and, at the extreme point, a reversed flow air jet.

Removal of the outside flash presented no difficulties, the weld being machined down to within ⅛-in. of the pipe surface. The flash welds withstood 60% of the number of reversals required to fail the parent metal, and sometimes the flash weld was much stronger than the parent metal.

The pipe tested generally withstood six or seven reversals before failing clear of the weld. A system of limit switches ensured that any slipping between the tube and the welding machine jaws during the upsetting stroke would be automatically indicated and an electronic timing device notified the inspector if the upset stroke was slower than the required minimum speed.

Signal lights enabled the inspector to reject bad welds. The welding machines had a graphic ammeter to record the current and duration of each weld, and a graphic pressure gage recording the pressure in the upsetting cylinders.

A total of 1,000 miles of pipe line was made, some 250 miles of 20-ft. lengths and the rest of 40-ft. lengths. The material was ordinary 0.1 to 0.15% carbon steel of 60,000 psi. tensile strength, and a yield point of 40,000 psi. For ductility, the specification called for an elongation of 18% on 8 in.

After 4,000-ft. lengths had been built up a single flash machine joined these together for winding on the drums, it being impossible to remove internal flash here. When the line was working fully, 1,000,000 gal. of gasoline per day was pumped across the Channel.

—J. S. Blair, *Trans. Inst. Welding*, Vol. 9, Feb. 1946, pp. 14-19.

Design of Locomotive Crankpins

Condensed from "The Journal of Applied Mechanics"

Since a press fit is known to be an area of extremely high stress concentration, and locomotive crankpins (pressed into the locomotive driving wheel) are a critical component in side rod drive locomotives, the Association of American Railroads has been conducting a research program into the fatigue life of full size (9½ in. dia.) crankpins. This paper presents a portion of the findings of this investigation.

Crankpins (either in laboratory tests or in service) may fracture inside the wheel fit at bending stresses that are only a small fraction of the fatigue strength of the same material without the press fit. And the initiation and growth of fatigue cracks in the wheel fit portion of the pin have been found to develop at much lower stresses than are required to break off the pin.

The crank pins used in these series of tests were forged from acid open hearth ingots; the initial forging temperature was 2050 F and the finishing temperature was approximately 1600 F. The pins were forged ½ to ¾ in. oversize, normalized and tempered in accordance with standard railroad shop practice, and then turned approximately to size.

Turning was accomplished with two roughing and one finishing cuts. The wheel bores, into which the crankpins were to be pressed, were bored with a straight cylindrical hole having a 1/32-in. radius at each end of the bore.

Four types of crankpins were tested during these experiments: Type 1. A straight cylindrical pin pressed into a wheel. Type 2. Same as Type 1, except that the outer end of the crankpin was tapered 0.008-in. on the dia. for a distance inside the wheel fit of 1¼ in. Type 3. Same as Type 1 except that the wheel fit portion was cold worked by rolling between three rollers. A highly polished surface and a reduction of 0.0013 to 0.0028 in. in dia. was obtained by this cold working. Type 4. Same as Type 1 except that the wheel fit portion of the pin was flame hardened.

The first group of eight crankpins to be flame hardened all exhibited thermal cracks when Magnafluxed after hardening. To remove these cracks, 0.071 to 0.0108 in. of stock was removed by grinding. A second group of six pins was flame hardened and then Magnafluxed; all six showed thermal cracks, but they were not as severe as those in the first group. Following this, four of these were ground (0.038 to 0.040 in. was ground off to remove all the thermal cracks) and two were pressed into wheels without being ground.

The assembled crankpin and wheel units were tested as rotating cantilever beams. All crankpin assemblies were tested at 1500 rpm. for about 85 million revolutions (equivalent to approximately 300,000 miles on 72-in. locomotive wheels) unless the pin failed earlier. The wheels were pressed off after the test run and the wheel fits were Magnafluxed and photomicrographed if any fatigue cracks were detected.

The results of these tests are as follows:

Type 1 Crankpins. Fatigue tests were completed on 15 pins at stresses of 5,000 to 22,000 psi., and the lowest at which fracture occurred was 12,000 psi. after running 45 million revolutions (about 160,000 miles). At a stress of 5,000 psi., fatigue cracks 0.0045-in. deep in the wheel fit developed after an equivalent of 309,000 miles (86.7 million revolutions).

Type 2 Crankpins. Twelve Type 2 crankpins were tested at stresses of 5,000 to 19,000 psi. Only two pins broke off in the wheel fit; these occurred at 16,000 and 19,000 psi. after 20,800 and 14,850 equivalent miles (5.84 and 4.16 million revolutions, respectively). At stresses of about 5000 psi., fatigue cracks 0.003-in. deep in the wheel fit were evident after 90 million revolutions (about 321,000 miles).

Type 3 Crankpins. The tests at stresses of 7,000 to 22,000 psi. of 10 Type 3 pins

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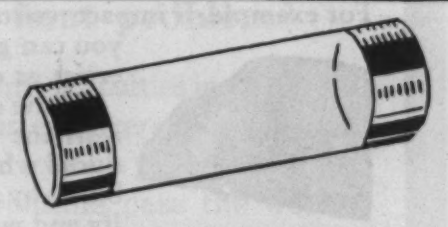

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showed that 8 pins completed test runs of 85 million revolutions (300,000 equivalent miles). All pins of this type showed fatigue cracks in the wheel fit portion.

Type 4 Crankpin. The results of 13 pins tested indicated that these had a greater fatigue life than either Types 1 or 2, but not as great as the life exhibited by the Type 3 pins.

Tabular Summary of Test Results

Type	Safe Allowable Stress to Prevent Breaking Off Inside Wheel Fit, Psi.	Safe Allowable Stress to Prevent Formation of Fatigue Cracks, Psi.	Performance Rating, %
1	11,000	less than 5,000	100
2	15,000	5,000	136
3	over 22,000	9,000	over 200
4	16,000 to 18,000	11,000	146-164

Note: All pins were made of plain carbon steel, normalized and tempered, and having a carbon content of 0.52% and manganese of 0.80%.

—O. J. Horger & W. I. Cantley. *J. Applied Mechanics*, Vol. 13, Mar. 1946, pp. A-17 to A-33.

Plastics in Aircraft Design

Condensed from "Mechanical Engineering"

An efficient wing maintains a smooth surface free from wrinkles throughout all flight conditions, consists of just enough stressed material to support design loads with an over-all margin of safety of no more than 15%, and is essentially monocoque in structure to facilitate production and reduce man-hours and costs.

Stressed thin sheet-metal panels have "local instability", so that most air frames comprise component sections of a semi-monocoque character which have been stiffened by attached reinforcing members. Use of high-strength plastics molded by low-pressure methods overcomes the disadvantages and limitations peculiar to fabrication of reinforced thin-metal bodies.

Resin-impregnated Fiberglas lamination has 75 to 90% of the tensile and compression strengths, 130 to 175% of the flexure value, 20 to 25% of the modulus of elasticity, 33% of the allowable bearing value, and 45% of the shear value of aluminum alloy.

The discrepancies in the relative strengths are of no disadvantage to a sandwich-type structure. Plastic-sheet material can be laminated in a tapering section, thus utilizing the effective efficiency of the sheet. A core comprising a low-density substance may be combined with high-strength plastic facing sheets to produce a greater moment of inertia than is possible with a stiffened metal panel for the same weight per unit length of span. These factors contribute to the realization of a pure-monocoque-shaped shell.

The trend in low-density materials is toward a resinous expanded or foamed product. Strong light-weight core materials, suitable for efficient sandwich construction, are now available.

A design of a cored plastic tubular-type monocoque wing is proposed and is compared with a typical metal wing. Using the bag-molding principle, the plastic wing can be shaped in one complete operation, and on and in one set of molds. This will result in a reduction in necessary tools and assembly jigs and in production man-hours.

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Distribution of plastic is more conducive to an optimum saving of weight. The proposed plastic wing is about 25% lighter than the metal wing.

Present indications point toward the early realization of a production plastic wing. If due consideration is given to the inherently useful properties of plastics, and particularly to the fact that they do not lend themselves to metal-design practices, it will be an efficient as well as an economical one.

—W. I. Beach. *Mech. Engineering*, Vol. 68, Mar. 1946, pp. 225-232.

Aluminum Casting Stability

Condensed from "American Foundryman"

Reports from various sources indicate that some difficulty is encountered with aluminum castings that are machined after heat treatment. Dimensional changes occur after machining, and these are often of such magnitude that the casting must be scrapped or a great deal more work must be done in order to save the piece.

Since this problem is of particular importance to some producers, the AFA appointed a subcommittee to investigate the causes and to submit suggestions. The committee contacted various persons familiar with the problem and assembled the information in this report.

In general, dimensional changes in aluminum alloy castings are caused by residual stresses resulting from plastic deformation or by density changes during heat treatment. Drastic quenching from solution treatment temperature, especially in castings with widely varying sections, can produce locked up stresses within the casting. Machining operations will release these stresses and cause deformation.

Slightly dull tools will cause plastic deformation, which may also result in dimensional changes. Improper support of the casting during machining may be a source of trouble because of the low yield strength of the alloys.

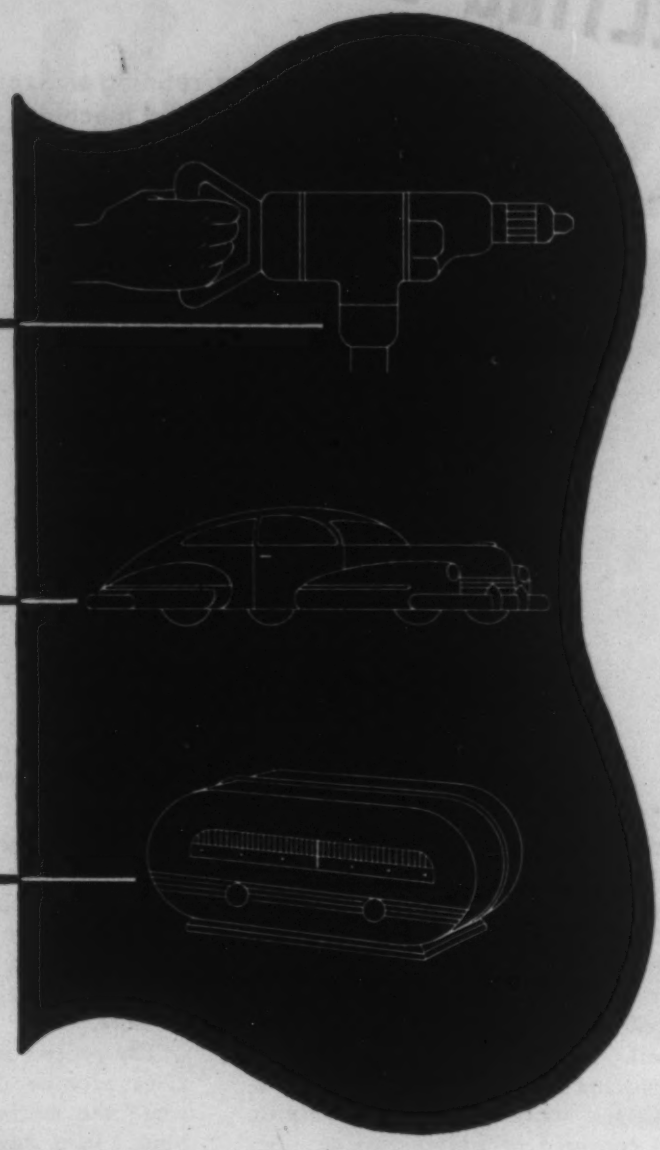
Aging usually causes a change in the density of an alloy. This change is due to volume changes in the alloy as precipitation progresses. These changes will produce locked up stresses, which can cause dimensional changes during machining.

With the exception of those cases of dimensional changes caused by improper support during machining or because of the use of dull tools, the recommended procedure for the prevention of dimensional changes involves some kind of stabilizing treatment. The suggested treatments include a subzero stress relieving operation; aging the castings four weeks at room temperature; stabilizing the castings by preheating in boiling water after quenching; and annealing by heating for various lengths of time at temperatures ranging from 350 to 700 F.

When heat-treatable alloys are used, annealing usually produces a marked decrease in the mechanical properties of the casting, but this is very often secondary in importance to dimensional stability. In the case of non-heat treatable alloys, annealing has no effect on the properties of the castings.

—*Am. Foundryman*, Vol. 9, Feb. 1946, pp. 65-69.

DO THEY...



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Let Acme know the strains and stresses your product or product part has to meet. Then depend upon Acme to suggest the right alloy for the Acme Aluminum Casting to be produced for your specific purpose. Acme's Engineering Department can help you choose between a sand or permanent mold casting, and may even suggest design changes that will mean important savings to you in metal and machining costs.

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MELTING and CASTING

Melting, alloying, refining and casting methods, furnaces and machines. Iron and steel making, nonferrous metal production, foundry practice and equipment. Die casting, permanent mold casting, precision casting, etc. Refractories, control equipment and accessories for melting furnaces.

Blast Furnace Operation

Condensed from "Iron and Steel Engineer"

The blast-furnace which was operated under elevated top pressure has a hearth area of 572.5 sq. ft., bosh area of 707.1 sq. ft., and stock-line area of 314.1 sq. ft. It is 107 ft. 8½ in. from the iron notch to tunnel ring. The volume is 46,230 cu. ft. from the center-line of tuyeres to the closed bell. It has 18 tuyeres and a 15-ft. diam. bell.

In preparing for elevated pressure operation, changes above the furnace-charging platform consisted of adding two gas-lines from the uptakes to introduce the furnace pressure on top of the bell. A third line vented this pressure to the atmosphere. Counterweights were added to the revolving hopper. The diam. of the stock-rod was reduced to 1 in., and a protecting tube carried to the top of the structure.

A butterfly valve was introduced in the water-discharge line from the gas washer, and operated by float control to regulate the water level in the bottom of the washer. The restricting valve actually controlling and maintaining the pressure in the gas-washer, dust catcher, downcomers, and furnace top was constructed of three 30-in. butterfly valves. In addition, three 12-in. through pipes controlled by solid plate disks were placed in the line.

After the furnace has operated satisfactorily under usual low top pressure, the back pressure was increased ½ psi. per day until 10 psi. was reached. This pressure was maintained for nine days, when an accident occurred which upset operations. During the following several months, there were more short periods during which the furnace was operated under elevated top pressure.

Consistent results were not obtained because of various delays encountered during the experiment. Some were directly due to elevated pressure operations, others were ordinary run-of-mine, with no connection with elevated top pressure, and still others were the results of the times.

Based on the very short periods of operation, indications are that the furnace operates much smoother under elevated pressure, moving steadily and having the ability to take more heat. Top temperatures are lower. On the same wind, production of dust will drop from 350 lb. to under 90, although as wind is increased to the point of equal gas velocities rising from the stock, flue-dust production again rises but not as high as without elevated pressure.

The process is metallurgically sound and gives promise of definitely proving itself when the mechanical difficulties are overcome. It is advantageous to operate with the reduced volume of gas resulting therefrom. The dust catcher and gas-washer each handle smaller volumes for a given rate of blowing.

Through elevated top pressure it becomes possible for a large-diameter blast-furnace to produce tonnages per sq. ft. of hearth area that have been accredited only to small furnaces. If adjustment is made for the abnormal delays encountered, tonnages will show a considerable increase.

—Frank Janecek. *Iron & Steel Engr.*, Vol. 23, Feb. 1946, pp. 88-94, 101.

The Feeding of Castings

Condensed from "The Foundry Trade Journal"

The extent of the freezing range is some indication as to the amount of feeding that can be given to a particular alloy. Thus, if it was shown that the particular alloy had a narrow freezing range, it would indicate that feeding would be difficult and that a large feeding head would be required, whereas with a wide freezing range, probably only a riser would be required, such as is common with cast iron.

With certain alloys the freezing range of the alloy may be misleading, due to the physico-chemical properties of the alloy, a classical example being phosphor bronze as compared with, say, gunmetal.

To obtain a solid casting in gunmetal, reasonably large heads are necessary, yet with phosphor bronze, in most cases it is useless to place large heads on the castings. It is found on examination of the majority of phosphor-bronze castings that they are porous and that gas is probably the reason for the reduced shrinkage.

Pouring temperature has a definite bearing on the amount of shrinkage and, consequently, the feeding necessary, and some indication of the effect can be obtained from the following data on pure aluminum.

The density of aluminum at room temperature is 2.703, and on heating progressively to 2.55 immediately before melting (658.7 C) and when just molten it is 2.382. On further heating to 1470 F it is 2.262. This reduction in density is indicative of the continued expansion of metal on heating and, therefore, demonstrates the excessive shrinkage that would be encountered on cooling from temperature well above the melting point. Almost all metals and alloys behave in a somewhat similar manner, and one can therefore expect excessive shrinkage from other metals and alloys when poured hot.

Three types of shrinkage defects found in castings are: (1) Shrinkage due to volume reduction on cooling; (2) interdendritic shrinkage, usually applied to nonferrous alloys; and (3) micro-shrinkage found in certain aluminum magnesium alloys. Ordinary shrinkage can usually be overcome by the use of proper feeding heads.

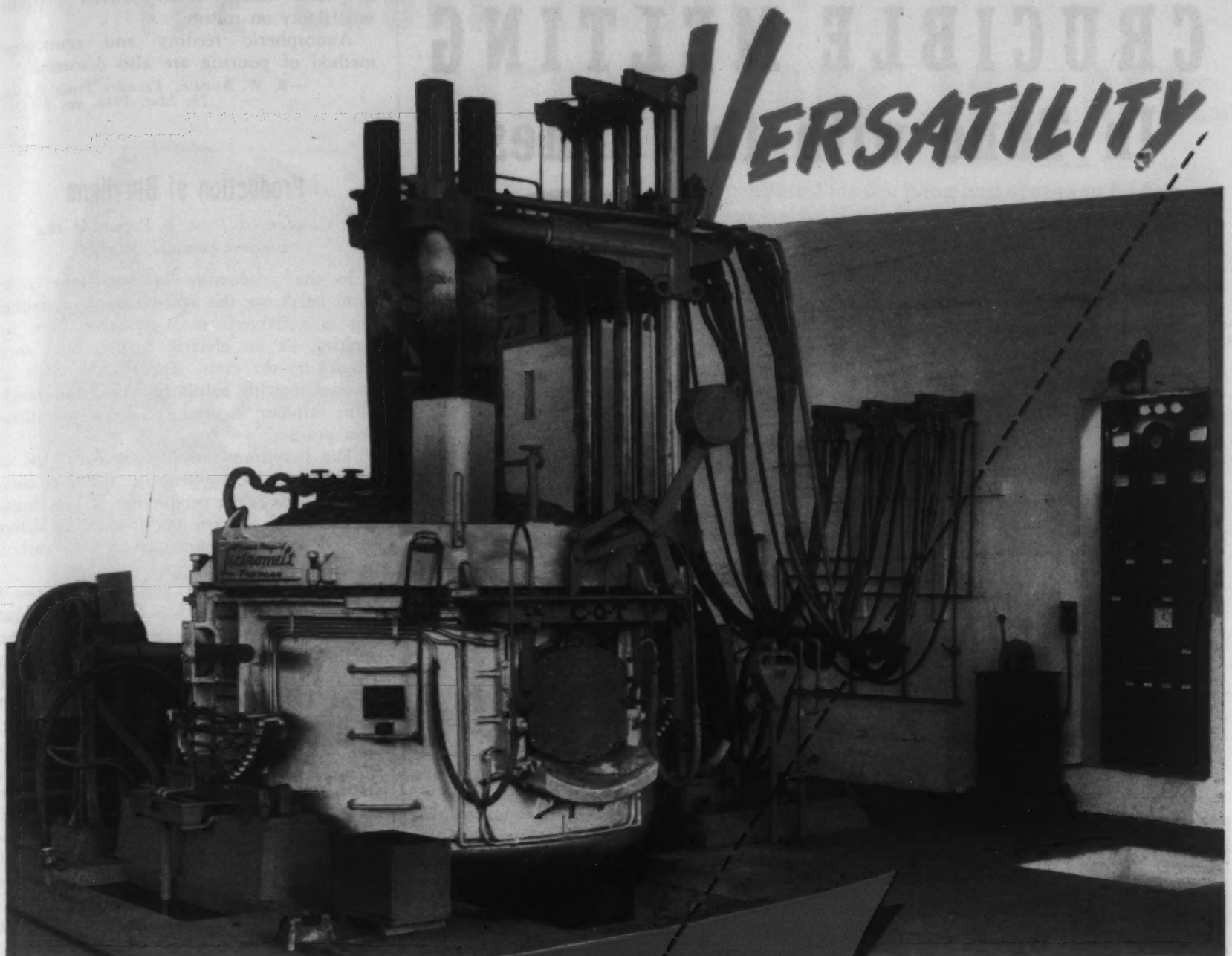
Interdendritic and miscroshrinkage are allied to physical changes in the metal and are not usually responsive to ordinary feeding, but can be prevented by controlled melting conditions, composition and design.

Interdendritic shrinkage is usually ascribed to the drainage of the eutectic downward, after crystallization, and the consequent minute crevices left in the drained portion of the metal. The tendency in many foundries is to pour metal on the dull side with the idea of preventing shrinkage.

Actually, in many cases shrinkage porosity in castings is due to dull pouring, especially in lighter sections, because the metal freezes too quickly to permit efficient feeding. High casting temperatures, apart from causing excessive shrinkage, reduce the rate of solidification because the excess heat of the metal is conducted to the mold before the freezing point of the metal is reached. The resulting gradual solidification not only produces a coarse structure, but sometimes promotes segregation.

Controlling the pouring temperature is therefore essential. Cast iron is a typical material that has a wide freezing range and passes through a pasty stage in which the metal is partly liquid and partly solid. Following the usual behavior of alloys during solidification, the first crystals that form on the walls of the mold, known as "chill crystals", are comparatively low in carbon.

There is an optimum speed at which any casting may be cooled to prevent shrinkage cracks in the chill crystals. Difficulty was recently encountered in the production of copper billets cast in chills for subsequent rolling into sheets. The chills were water cooled and examination revealed shrinkage cracks at the edges of the billets, due to too rapid cooling. Trial batches were made



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● The versatility of the Lectromelt Furnace in economically melting either large or small heats is of great advantage where the user requires a wide variety of castings. The entire heat may be tapped or part of the heat may be tapped and the analysis of the remainder altered as desired. This means economy of power, time, and metal.

Another phase of the Lectromelt versatility is that you may use either large bulky scrap or light fluffy scrap. In the production of quality gray and malleable iron it is possible to follow any of three procedures . . . Batch type cold melting, continuous cold melting type, or duplexing operations on molten metal. Steel and iron may be melted in the same furnace—in alternate heats if desired. This versatility means economy of operation and the production of the exact quality metal.

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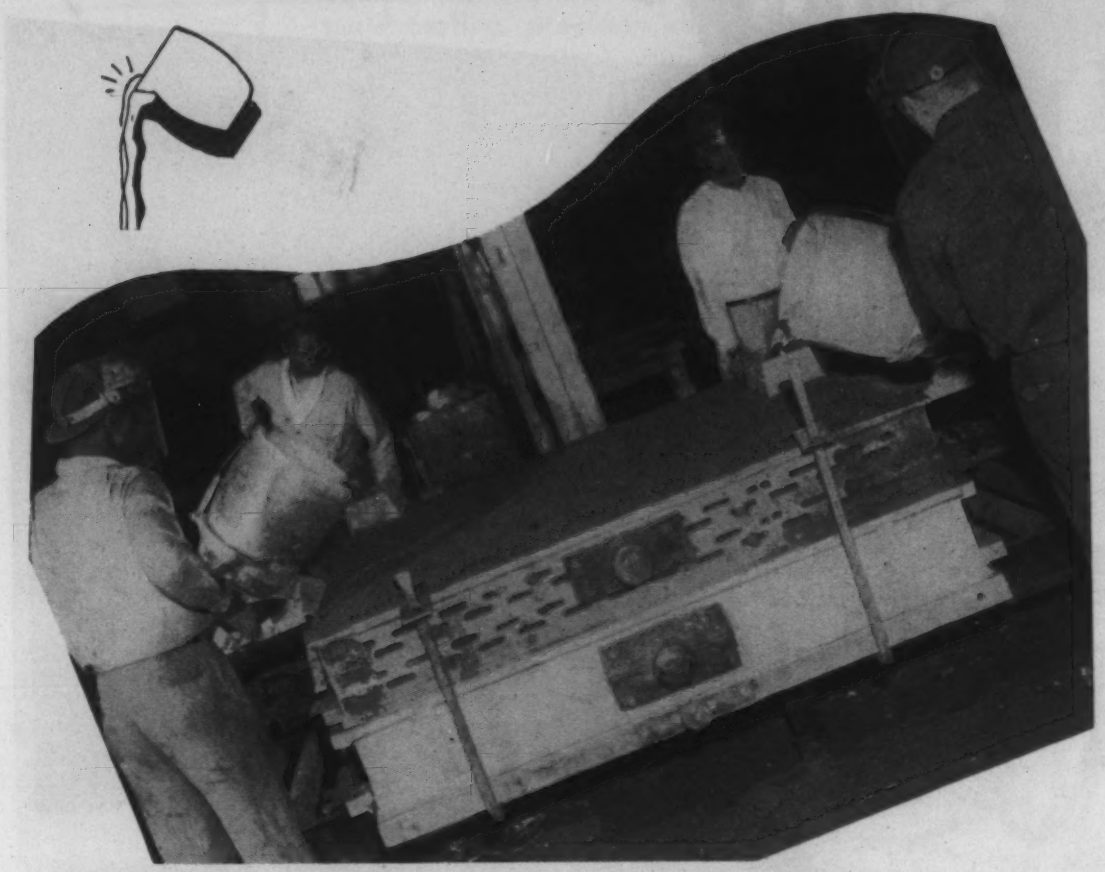

For a lighter piano with a cast aluminum plate. Metal melted in tilting type crucible furnaces, carried and poured with crucibles of 150 pound capacity. Photo courtesy Aluminum Company of America.

When you are confronted with unusual non-ferrous casting problems, crucible furnace melting is the most adaptable method—always.

Adaptable to the unusual, crucible melting is best always for the usual—your regular "run of foundry" work. In the coming "bread and butter" days, you can profit most by standardizing on Crucible melting. It is the wise foundryman's choice of today.

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in warm chills which proved perfectly satisfactory on rolling.

Atmospheric feeding and centrifugal method of pouring are also discussed.

—R. W. Ruddle. *Foundry Trade J.*, Vol. 78, Mar. 1946, pp. 253-257.

Production of Beryllium

Condensed from a Paper of the Electrochemical Society

In the production of beryllium oxide from beryl ore the acid-resistant crystalline ore is converted to a reactive form by melting in an electric furnace and then quenching the melt. The reactive material is treated with sulphuric acid, and beryllium sulphate is produced by a crystallization process.

The beryllium sulphate is converted to beryllium oxide by heating. Another common process is the production of beryllium-copper in an electric arc furnace by direct reduction of beryllium oxide with carbon in the presence of copper.

There are about 30 recognized minerals containing beryllium but only the mineral beryl is now of industrial importance. The commercial grades of beryl ore contain 11 to 13% BeO, 17 to 19% Al_2O_3, and 64 to 70% SiO_2, 1 to 2% alkali metal oxides and 1 to 2% iron and other oxides.

Beryl ore is produced only as a by-product of other minerals, chiefly mica, feldspar and lithium ores in pegmatite dykes. Beryl ore at its melting point of 1500 to 1600 C (2730-2910 F) is extremely active chemically and attacks rapidly all ordinary refractory furnace linings except carbon, which is therefore used.

The carbon lining requires replacement or repairs after three or four weeks' continuous use. All equipment in the crystallization process must be acid-resistant. Lead or glass-lined equipment is good.

Pure beryllium oxide has a melting point of 2570 C (4658 F), which is rapidly lowered by presence of impurities such as alkalis or silica. To avoid excessive sintering and fluxing, it is necessary to produce an oxide of high purity.

Refractory articles of beryllium oxide of high purity show a high thermal conductivity, high mechanical strength, and a good resistance to thermal shock. Electrical conductivity at elevated temperatures is remarkably low. The combination of high thermal conductivity and low electric conductivity is quite unusual.

As to the production of beryllium-copper alloy, laboratory tests indicate that the direct recovery of beryllium-copper from a heated mixture of beryllium oxide plus carbon plus copper rapidly decreases with increasing beryllium content. Since an alloy of around 4% beryllium is desired by the trade, it is necessary to rework the byproducts of the reaction containing beryllium carbide, beryllium oxide and carbon to obtain a complete recovery of the beryllium content of the beryllium oxide.

The affinity of the molten copper for beryllium decreases as the beryllium content of the copper increases. Overheated molten beryllium-copper dissolves considerable beryllium carbide and carbon monoxide.

THE COURT TASTER USED TO TAKE THE RAP..

Food prepared for the King had always to be first tried out by the Court Taster. If the food was not right—or if someone tried to poison the King—that was the Court Taster's hard luck. But when non-ferrous ingot is not made in accordance with your specifications—then it is your Foundryman who has trouble. Over 50 years in the refining of non-ferrous alloys, plus the most up-to-date smelting equipment and scientific laboratory controls, are your assurance that non-ferrous ingot ordered from Michigan Smelting will be exactly as ordered by you—will meet your specifications in every last detail.

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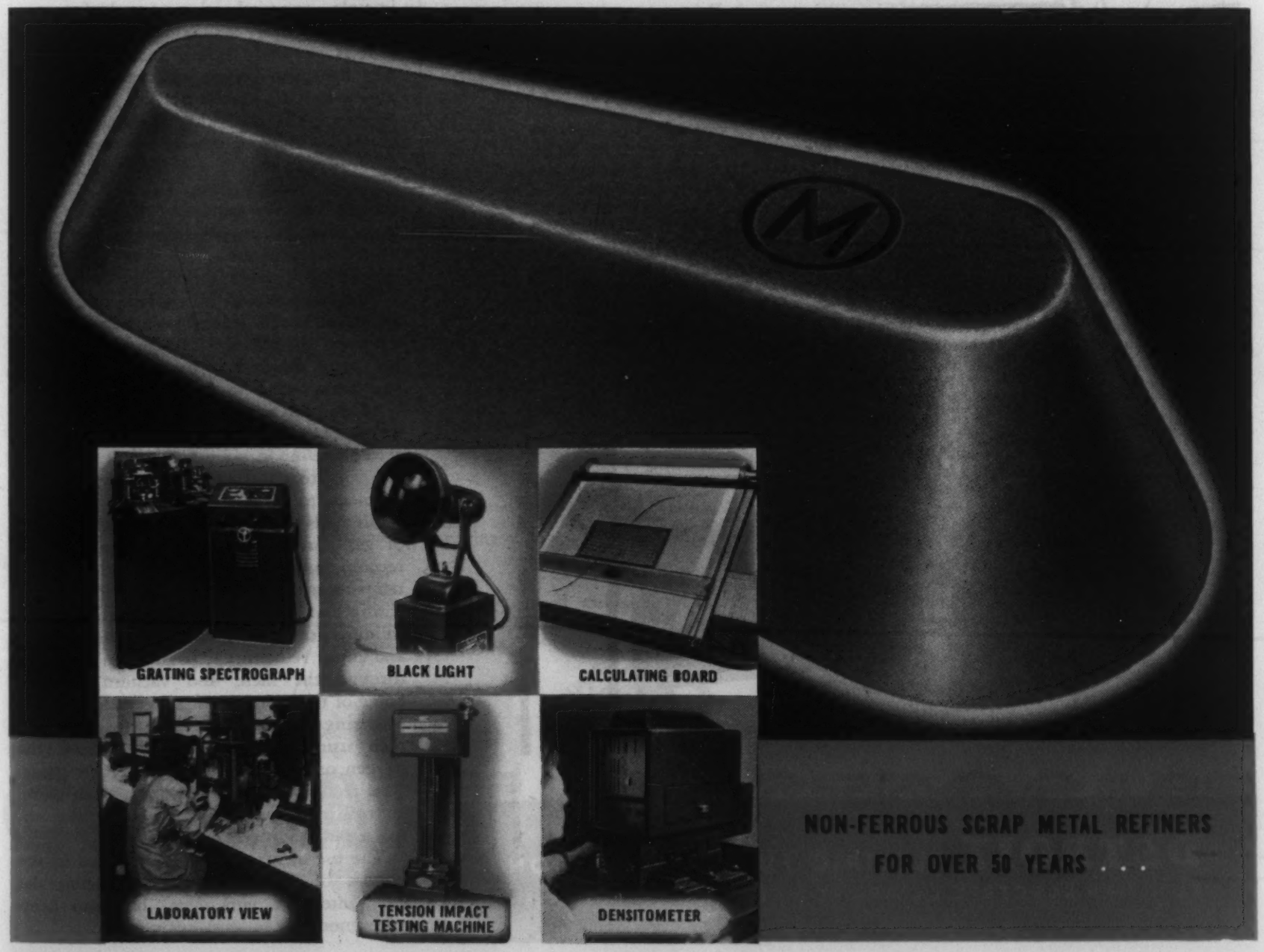

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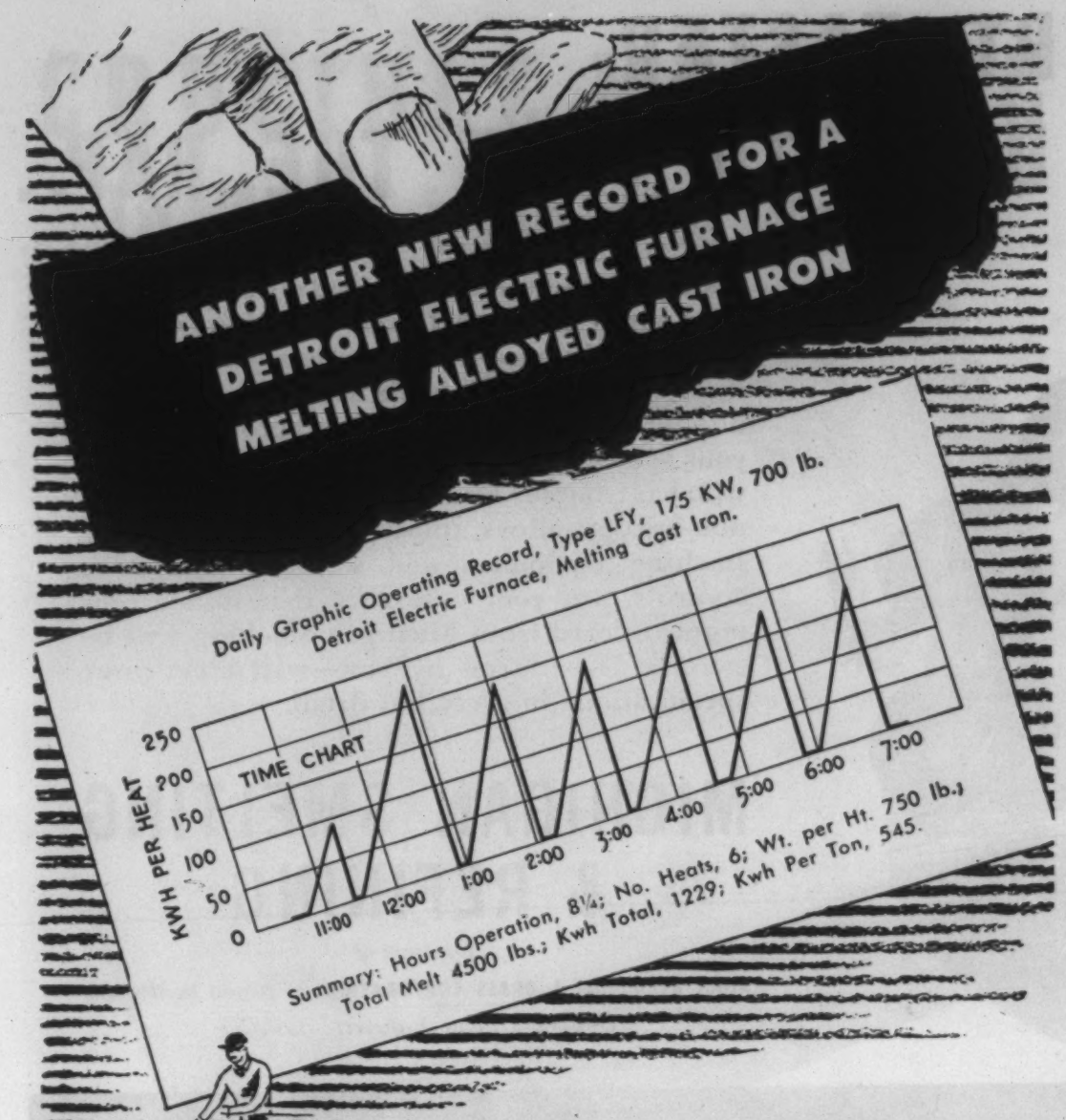
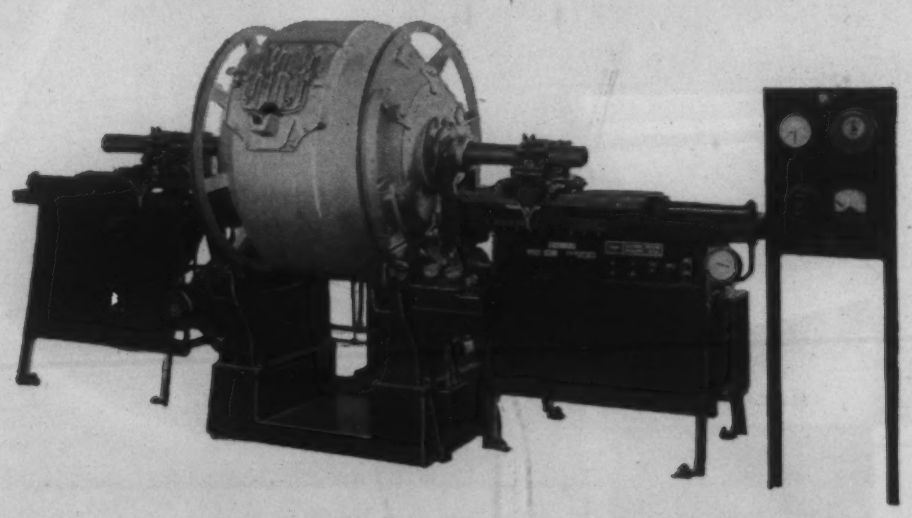


The speed and efficiency with which the Detroit Rocking Electric Furnace melts ferrous metals is clearly demonstrated in the above graph of a typical day's operation. In 8¼ hours, a Type LFY, 175 Kw, 700 lb. Detroit Electric Furnace melted six 750 lb. heats of cast iron, with only one man weighing charges, charging and operating the furnace. Total melt—4500 lbs.! Total power consumption—1229 Kwh! That's only 545 Kwh per ton, and because melting factors such as time, composition, and temperature were under constant and precise control, the metal was higher in quality as well as lower in cost. With conical shell design, the Type LFY Detroit Electric Furnace is equipped with hydraulic manual and automatic electrode control on stationary pedestals which also contain all electrical switches thus affording the operator finger-tip control. Send us your ferrous and non-ferrous melting requirements. Our engineers will be glad to study them without obligation and recommend the specific Detroit Electric Furnace that will speed economical melting in your plant.



DETROIT ELECTRIC FURNACE DIVISION
KUHLMAN ELECTRIC COMPANY • BAY CITY, MICHIGAN

The solids, consisting of beryllium oxide, carbon and beryllium carbide, form a thick mushy mixture on the surface of the alloy and can easily be separated. An arc furnace is preferable to an electric induction furnace for this process.

Because of the difficulty of removing impurities, pure grades of beryllium oxide, carbon and copper must be used. The beryllium copper produced by this process contains 4 to 4.25% beryllium, and less than 0.10% iron, 0.08% silicon and 0.06% aluminum.

—B. R. F. Kjellgren. *Electrochemical Soc.*, Preprint No. 89-5, Apr. 15, 1946, 12 pp.

Gases in Bronzes

Condensed from "The Foundry"

The unsoundness of bronze castings is usually due to the combined effects of solidification shrinkage and evolution of dissolved gases. According to Sievert's Law, the solubility of a gas in a metal is proportional to the square root of the partial pressure of the gas.

The solubility of hydrogen in copper is very nearly proportional to the temperature, while the solubility of hydrogen in molten copper-tin bronze is a function of the tin content, decreasing rapidly from 0 to 40% tin. While no direct measurement of the solubility of hydrogen in solid bronze has been made, the change in solubility at the solidus has been estimated to be approximately one-tenth that noted for pure copper.

It is generally agreed today that hydrogen, hydrogen-oxygen and water vapor are the principal causes of gas porosity in bronzes. The fact that carbon has been found to have a small, but appreciable, solubility in copper and bronzes indicates that the carbon gases, CO and CO_2, although believed to have negligible solubility, may be important secondary sources of gas unsoundness.

Sulphur dioxide supposedly is a minor source of porosity in copper and copper alloys, although it has been reported that the type of porosity caused by SO_2 does not harm mechanical properties. Nitrogen has been found to be inert to bronze.

It has been ascertained that hydrogen and oxygen can co-exist in molten bronze and recombine upon solidification of the melt. Also, hydrogen is said to react with oxides in metal to form steam.

Methods for dealing with the problem of gas porosity are numerous and include recommendations for controlled pouring temperature, atmosphere control, proper gating and risering, pre-solidification (slow solidification of the metal in the crucible and rapid remelting), passing an inert gas through the melt, and vacuum melting. Some of the more recent suggestions involve oxidizing the melt to remove hydrogen and then using a deoxidizer to remove the oxygen or to convert it into an inert oxide. This technique might be carried out using an oxidizing flux during melting and using a phosphorus as a deoxidizer.

The use of manganese ore charged in the bottom of the crucible for reducing the gas content of gun metal has also been recommended.

DO YOU NEED A BETTER REFRACTORY?

● Corhart Electrocast Refractories are high-duty products which have proved considerably more effective than conventional refractories in certain severe services. If your processes contain spots where a better refractory is needed to provide a balanced unit and to reduce frequent repairs, Corhart Electrocast Refractories may possibly be the answer. The brief outline below gives some of the basic facts about our products. Further information will be gladly sent you on request.

Corhart Refractories Company, *Incorporated*, Sixteenth and Lee Streets, Louisville 10, Kentucky.

"Corhart" is a trade-mark, registered U. S. Patent Office.

PRODUCTS

The Corhart Refractories Company manufactures Electrocast refractory products exclusively. Corhart Electrocast Refractories are made by melting selected and controlled refractory batches in electric furnaces and casting the molten material into molds of any desired reasonable shape and size. After careful annealing, the castings are ready for shipment and use.

Three Electrocast refractory compositions are commercially available:

CORHART STANDARD ELECTROCAST — a high-duty corundum-mullite refractory, with density of approximately 183 lbs. per cu. ft.

CORHART ZED ELECTROCAST—a high-duty zirconia-bearing aluminous refractory, with density of approximately 205 lbs. per cu. ft.

CORHART ZAC ELECTROCAST—a high-duty zirconia-bearing refractory, with density of approximately 220 lbs. per cu. ft.

Other Corhart products are:

CORHART STANDARD MORTAR—a high-temperature, high-quality, hot-setting cement for laying up Electrocast, or any aluminous refractory.

CORHART ACID-PROOF MORTARS — rapid cold-setting, vitrifiable mortars of minimum porosities.

CORHART ELECTROPLAST—a high-temperature, hot-setting plastic refractory, designed for ramming and made from crushed Standard Electrocast.

CORHART ELECTROCAST GRAINS—Standard Electrocast crushed to desired screen size for use in many commercial applications.

PROPERTIES

Due to the unique method of manufacture, the Electrocast refractory line possesses a combination of characteristics found in no other type of refractory. Data on properties will be sent on request.

POROSITY: Apparent porosity of Corhart Electrocast refractories is practically nil—therefore virtually no absorption.

HARDNESS: 8-9 on Mineralogist's scale.

THERMAL EXPANSION: Less than that of conventional fire clay bodies.

THERMAL CONDUCTIVITY: Approximately one and one-half times that of conventional fire clay bodies.

REFRACTORINESS: Many industrial furnaces continuously operated up to approximately 3000° F. are built of Corhart Electrocast.

CORROSION: Because of exceedingly low porosity and inherent chemical compositions, Corhart Electrocast refractories are resistant to corrosive action of slag, ashes, glasses, and most non-ferrous metals as well as to disintegrating effects of molten electrolyte salt mixtures.

APPLICATIONS

Most heat and metallurgical processes present spots where better refractory materials are needed, in order to provide a balanced unit and reduce the expense of repeated repairs. It is for such places of severe service that we invite inquiries regarding Corhart Products as the fortifying agents to provide the balance desired. A partial list of applications in which Corhart Electrocast products have proved economical follows:

GLASS TANKS—entire installation of sidewalls and bottoms, breastwalls, ports, tuckstones, throats, forehearths, bushings, bowls, recuperators, etc., for lime, lead, opal and borosilicate glasses.

ELECTROLYTIC CELLS—for production of magnesium and other light metals.

SODIUM SILICATE FURNACES — sidewalls, bottoms, and breastwalls.

PIGMENT FRIT FURNACES—complete tank furnaces for melting metallic oxides and salts for pigment manufacture.

ALKALI AND BORAX MELTING FURNACES —fast-eroding portions.

BOILERS—clinker line.

RECUPERATORS—tile, headers, separators, etc.

ENAMEL FRIT FURNACES—flux walls and bottoms.

BRASS FURNACES—metal contact linings.

ELECTRIC FURNACES—linings for rocking type and rammed linings of Electroplast for this and other types.

NON-FERROUS SMELTERS—complete hearths, sidewalls, and tapping hole portions.

QUALITY ECONOMY ENDURANCE

CORHART ELECTROCAST REFRACTORIES

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Virtually all the brass mills in North America use the Ajax-Wyatt induction melting furnace, for it has the lowest metal losses in the field — less than 1% — with superior temperature control and unapproached economy of operation on high production schedules such as we have today.

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"Falls Brand" Alloys

"FALLS" NO. 14 ALLOY
makes
Solid Brass and Bronze Castings

If you make bronze castings to withstand pressure, use "FALLS" NO. 14 ALLOY and save 5 to 50% of the castings that would be rejected on account of leakage after machining.

—reduces casting losses due to porosity in composition, valve metal, bronzes, etc.

—deoxidizes — by reducing Metallic Oxides.

—densifies — by producing a close-grained structure.

WRITE FOR COMPLETE DETAILS

NIAGARA FALLS SMELTING & REFINING CORPORATION
America's Largest Producers of Alloys
BUFFALO 17, NEW YORK

While it is generally agreed that gases in bronzes are usually harmful, the presence of small amounts of dissolved gas is said to be beneficial in distributing shrinkage porosity more uniformly throughout a casting that necessarily must be inadequately fed.

—R. A. Colton. *Foundry*, Vol. 74, Mar. 1946, pp. 88-89, 134, 136, 141.

Aluminum Die Castings

Condensed from "Light Metals"

On technical and physical grounds, it might, with some justification, be considered a partial misnomer to call the pressure process a true casting process, because the metal is not poured freely in the mold, as it is to make sand castings or gravity die castings; thus, in these cases, the nature of the final product is conditioned by many factors beyond the operator's control.

There are two types of machine, known as the goose-neck machine and the cold-chamber machine. While goose-neck machines are making very large numbers of castings in aluminum alloys, they have definite drawbacks.

Owing to the low pressures of 400 to 500 psi. used, the castings are always somewhat porous in the middle. Also, as the iron goose-neck is always suspended in the molten aluminum, iron pick-up is excessive, and may easily reach 4%, though with normal working it does not often exceed 1.5%.

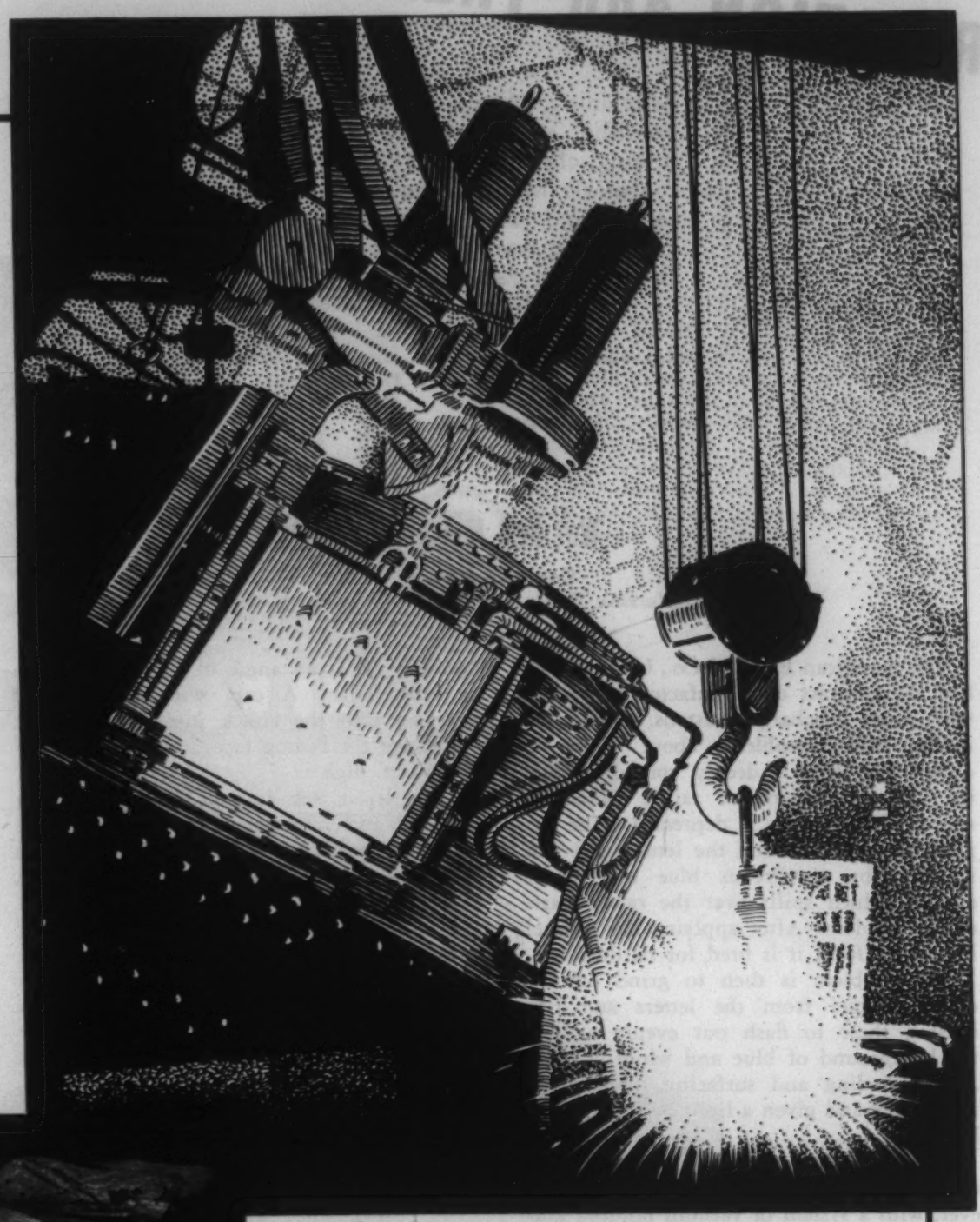
The die for the cold-chamber machine consists of two substantial blocks of steel, known as "die sides," having well-machined surfaces that fit together under a high pressure (11,250 lb.) so that the injection pressure does not force them apart. Metal is poured into the pouring hole and, by the movement of a small lever, the ram is pushed quickly forward and the metal injected into the die cavity under a pressure of 6,750 psi. Another lever opens the die, and small ejector pins loosen the casting and enable it to be removed by means of a pair of pliers. The die is closed again by means of another lever, and the operation is repeated.

The tolerances on a pressure die are closer than those on a gravity die. Such limits as ±0.001 were often worked to during the war. Pressure castings are also easily fettled. The gate may be as thin as 0.015 in. and the butt of excess metal can be broken from the casting by hand.

Disadvantages of the process include the high cost of the die. As it has to be made to withstand the erosive action of molten aluminum at high pressures and temperatures, only certain alloy steels can be used. Small errors in the castings may result from wear of the dies and these errors may go unnoticed until many castings are made.

Pressure die castings also do not, in general, lend themselves readily to heat treatment, or to anodizing or plating. Apart from the question of overall size, the pressure process is not suitable for the production of castings having thick sections or lumpy portions.

—E. Carrington. *Light Metals*, Vol. 9, Mar. 1946, pp. 152-160, 162.



DRAWN FROM A MARGARET BOURKE-WHITE PHOTOGRAPH. COURTESY OF ALLEGHENY LUDLUM STEEL CORPORATION.

P. B. SILLIMANITE

for direct arc electric furnace roofs

If you are "hitting the roof" on your electric melting furnace check the advantages to be gained by using P. B. Sillimanite Brick, Shapes or Ramming Mix for roof construction. P. B. Sillimanite roofs are in service today on furnaces ranging from 50 lbs. to 50 ton units, melting a wide range of steels and alloys. P. B. Sillimanite Ramming Mix is usually supplied for monolithic roofs of furnaces 1000 lbs. and under. Brick or Special Shapes are recommended for the larger roofs.

WRITE FOR BULLETIN NO. 311 FOR COMPLETE SERVICE DATA.

CHAS. TAYLOR SONS Co.

MANUFACTURERS OF REFRACTORIES • CINCINNATI • OHIO • U.S.A.

FABRICATION and TREATMENT

Machining, forging, forming, heat treating and heating, welding and joining, cleaning and finishing of solid materials. Methods, equipment, auxiliaries and control instruments for processing metals and nonmetals and for product fabrication.

Wet Belt Finishing

Condensed from "Production Engineering and Management"

The American Emblem Co., Utica, N. Y., had the contract of manufacturing 1,000,000 naval discharge buttons. They are round, bronze emblems about ⅝-in. in diam. The face is deeply coined so that the rim and letters are raised while the rest of the emblem is depressed. The depressed portion around the letters and rim is filled by a vitreous blue and white enamel, which spills over the raised parts of the emblem. After applying the enamel in a pasty form it is fired for hardness.

The problem is then to grind off the excess enamel from the letters and rim causing these to flash out evenly against the background of blue and white enamel. After grinding and surfacing, the button is oxidized and given a light buff for added luster.

By the original production method production was only 300 buttons per hr. However, with a system of vacuum holding and compressed air ejection plus a Porter-Cable wet belt machine, the production was speeded to 800 pieces per hr. in view of improvement in the grinding and surfacing.

Using the wet belt method the button is placed in a spindle-mounted collet and held in place by a vacuum. The fixture is then operated and the button comes in contact with an abrasive belt coated with silicon carbide particles and the excess enamel is ground off. After being ground, a compressed air machine ejects the finished button and deposits it in a tray.

Each button is soldered to a small circular disc about the same size as the face button, this rear part of the button clamping into the wearer's lapel. Dry grinding would melt the solder. The wet abrasive belt is backed by a padded platen to provide resiliency for the button as it contacts the belt. The button, when it contacts the abrasive area, is slightly impressed into the belt during the grinding operation and the conformance of the belt to the face of the button results. The entire surface area is ground and surfaced in one operation.

The coolant used is a mixture of 40 parts of water to 1 part of soluble oil. Key to the high production is an ingenious fixture, a chuck, with an opening to accept the rear part of the button holding it snugly in place. The outside of the chuck was ground off at an angle of 45 deg. to form a knife edge. A cap, with a bore, was pressed into the chuck just large enough to accept the button face disc. The cap was 0.040 in. high.

The chuck was formed on the end of a spindle and mounted in a swinging arm on the fixture. The pivot was a bronze valve with two passages connected to a vacuum pump and compressed air supply. It was so arranged that when the lever was swung to discharge, compressed air blew out the chuck; when the lever was moved toward the belt, the air was shut off and suction became effective.

—W. F. Schleicher. *Prod. Engineering & Management*, Vol. 17, Feb. 1946, pp. 94, 96.

Cold-Die Quenching

Condensed from "Steel"

Small, thin parts are hardened without distortion by quenching in water-cooled steel dies after heating. For example, large thin thrust washers, blanked out of cold-rolled steel and that have oil grooves machined half way through their thickness, often come from the blanking and machining operations with a bow of 0.050 in. After hardening, the washers are held flat within 0.005 in.

This method is limited to parts of large surface and small mass. A piece of 0.030-in. thick steel will cool to below 120 F from 1600 F about twice as fast when gripped between a pair of dry, cold dies as it will if quenched in oil.

The dies rarely have more than a few ¼-in. holes drilled parallel to the working face and ¼-½ in. away from it. These water channels serve only to return the entire block to a cold condition after a piece is quenched and before the next part is charged into the die, and not for any immediate cooling of the part.

Only a very light press, the dies, a ¼-in. hose connection to the nearest water line, and a drain are required. An ordinary "kick-press", modified by the addition of a latch to hold it closed, handles virtually all flat work. For more complicated shapes, a self-contained hydraulic vise is about the best type of "press".

This quenching process has been very successfully applied to case-hardened parts and to virtually all types of steel. As hardenability of the steel being treated increases, considerable thicknesses can be quenched fully for a given amount of surface in contact with the die.

In thin sections, even a plain-carbon steel will quench out to 65 Rockwell C. When a part is so thin and light that it quenches from lying on the lower die before there is time to close the upper dies, then the parts will warp much worse than if they were oil quenched.

Parts to be die quenched must be clean and free from scale. Often it is possible to limit scale under oxidizing conditions, by rapid heating. This must be done on a precision basis and the cycle held within a few seconds of the same time for each piece.

Dies are made of heavy blocks of cold-rolled steel of suitable size, and are carburized, hardened, and ground to final contour. Actual working surfaces are hard chromium plated to a thickness of 0.001 to 0.0015 in. Following this, the entire die should be cadmium plated.

With this process, much labor is saved in straightening, scrap is reduced, and product is uniform and really straight.

—A. F. Gallistel. *Steel*, Vol. 118, Mar. 4, 1946, pp. 128-129, 172, 174, 176, 178.

Welded Valves

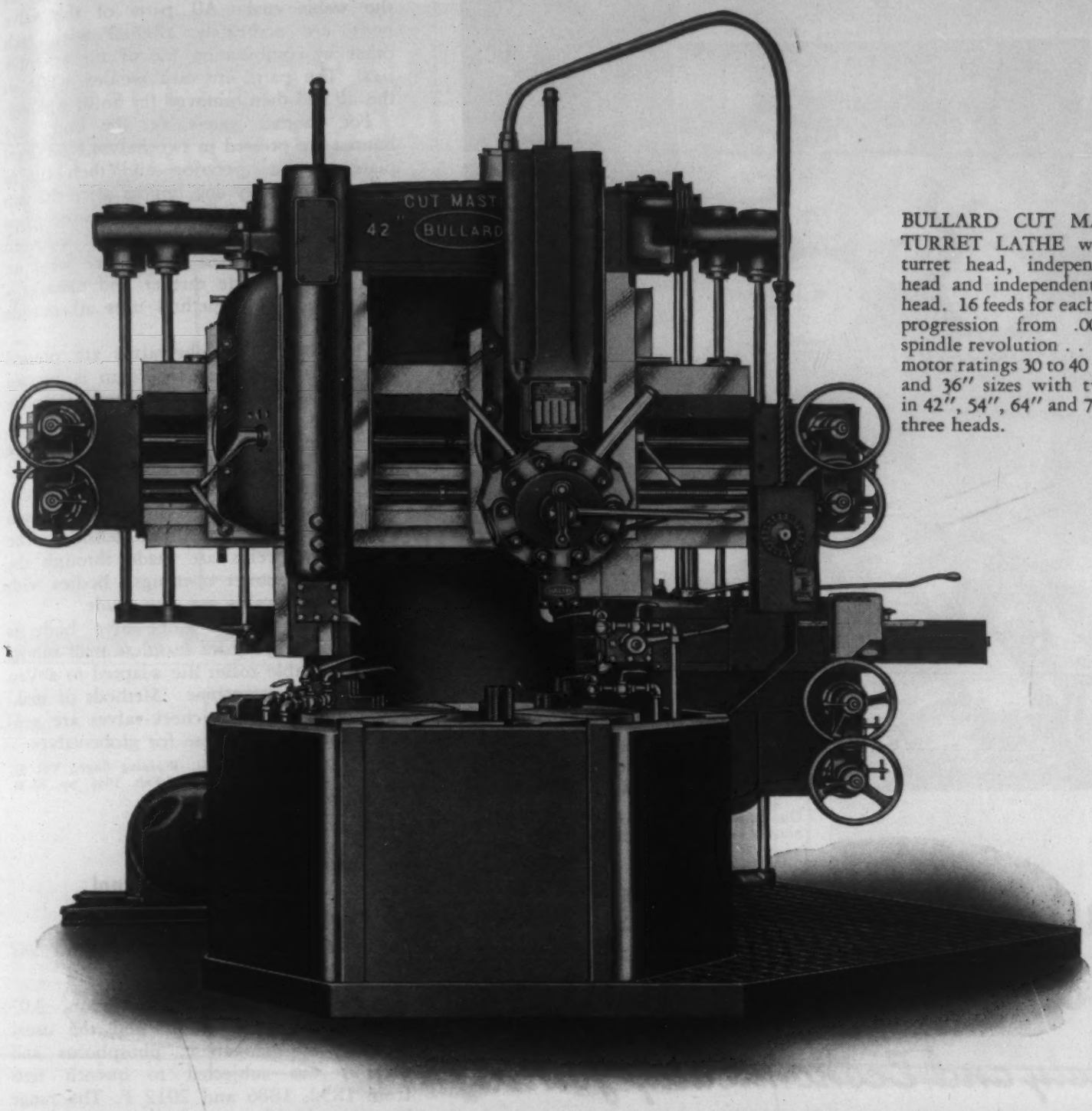
Condensed from "Welding Engineer"

When cast and forged valves could not be obtained, the U. S. Navy turned to welding as a means of fabricating gate-valves, globe-valves, and swing check-valves. This method is ideally suited to those applications where special valves are needed or where only a few valves of a type are to be made.

Important advantages of welded fabrication are the elimination of expensive patterns and the much shorter period of time required to make the finished product. Weight reduction has resulted from use of stronger rolled materials instead of castings. Valves can be fabricated by welding light plate material of nonferrous alloys which would be virtually impossible to cast.

In designing the valves, the attempt was made to have all parts made with common shop tools. In making a ventilating gate-valve, the outside wrapper of light-gage sheet is bent between a male and female die in an ordinary hydraulic press. The disk guides are then welded to the wrapper, using a jig to hold the assembly. Following this, the nozzles are cut from standard steel tubing and faced with 25-20 stainless steel; rough machining on the seat faces follows. The body side plates are sheared to shape, while the body flanges are flame cut with a standard pantograph-type machine. A special jig is used to drill the nozzle openings of the side plates.

Guide strips are assembled with the wrapper sheet in a jig that has machined slots to hold the strips in order to prevent



BULLARD CUT MASTER VERTICAL TURRET LATHE with swiveling main turret head, independent left-hand ram head and independent non-swiveling side head. 16 feeds for each head in geometrical progression from .0026" to .500" per spindle revolution . . . 20 table speeds . . . motor ratings 30 to 40 hp. Available in 30" and 36" sizes with two heads only . . . in 42", 54", 64" and 74" sizes with two or three heads.

UNIT PRODUCTION COSTS ARE LOWER

when you cut machining time both ways

1. CUT TIME ON CUTS

Bullard Cut Master Vertical Turret Lathes remove more metal in less time than any other machines of the same type because they offer the best combination of rigidity, freedom from vibration, smooth flow of power and wide range of speeds and feeds. That's why they permit you to take full advantage of the latest developments in cutting tools for heavy, accurate cutting.

2. CUT TIME *BETWEEN* CUTS

Bullard Cut Masters keep lost time between cuts at the minimum because of fast chucking — two or three heads working simultaneously — independent rapid power traverse of each head in any direction which brings tools quickly to within a fraction of an inch of the work — quick and easy engagement of proper feed and convenient location of all operating controls.

For further reasons why Bullard Cut Masters give peak production by *cutting time on and between cuts*, write for your free copy of Bulletin CVTL-4-1-46, today. The Bullard Company, Bridgeport 2, Connecticut.

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Products which otherwise would be difficult or expensive to make in one piece are being made in several pieces and brazed.

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Strong, leak-proof joints are made and the completed units are discharged from these furnaces—clean and bright. Any number of joints in the same product or any number of pieces can be joined at one time.

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Investigate This Process for Joining Your Metal Parts

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The Electric Furnace Co., Salem, Ohio

Gas Fired, Oil Fired and Electric Furnaces---For Any Process, Product or Production

the guides from curling the assembly as the welds cool. All parts of the valve body are accurately aligned with each other by combination use of the assembly jigs. The parts are tack welded while in the jig and then removed for finish welding.

For another gate-valve, the body and bonnet are pressed in two halves from steel plate in one operation and then cut to separate the body and bonnet after the two halves have been welded. The guide strips for the gate are either inserted between the two body halves with a vee weld on each side or made thicker and used as a chill strip. This method uses all outside welds.

The bodies of globe-valves are pressed in two halves. The diaphragm is pressed to shape and cut to a sheet-metal template which fits the inside contour of the body, and is welded into one body half, before welding the two halves together. The second half is then assembled, and the circumferential flange and longitudinal seam welds are made from the outside. The final inside welds are made through the nozzle and bonnet openings. Bodies with only outside welds are also made.

Another type of globe-valve body is swaged to shape from seamless steel tubing with a suitable roller die adapted to a Van Stone flanging machine. Methods of making bodies of swing check-valves are generally the same as those for globe-valves.

—Ernest Califro. *Welding Engr.*, Vol. 31, Feb. 1946, pp. 35-38.

Annealing Valve Steel

Condensed from "Schweizer Archiv fur angew. Wiss. and Technik"

A steel containing 0.48 carbon, 3.07 silicon, 9.13% chromium and the usual contents of manganese, phosphorus and sulphur was subjected to quench tests from 1832, 1886 and 2012 F. The range between the first two temperatures was found to be the best.

Microhardness tests and microphotographs show that fast quenching causes the retention of a certain portion of the austenite with the rest of the structure being martensite. Single annealing caused the martensite to become troostite while the austenite changed to martensite.

Double annealing resulted in very uniform material with a micro vickers hardness of 330 to 340, at a test load of 66.1 grams. The quenching was done in water, the annealing in air at 1382 and 1472 F, respectively.

—W. Felix & H. Dinner. *Schweizer Archiv f. angew. Wiss. & Technik*, Vol. 11, Dec. 1945, pp. 386-392.

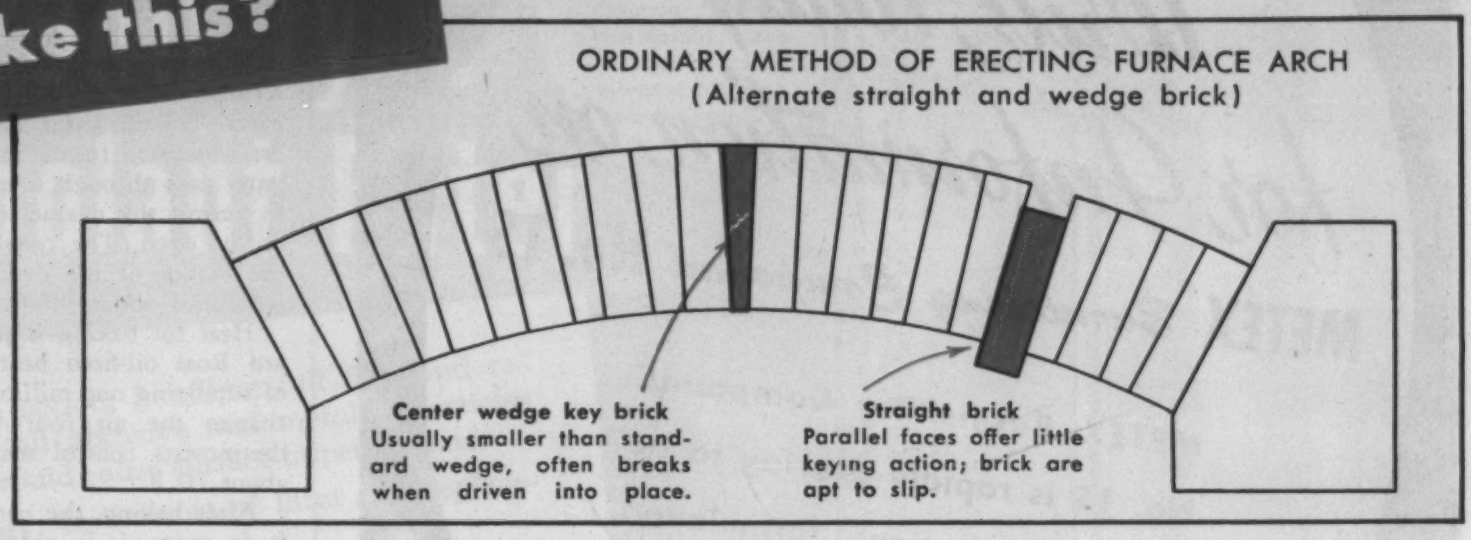
Enameling Castings

Condensed from "The Iron Age"

The ITE Circuit Breaker Co. of Philadelphia has designed an enameling unit that combines speed, economy and flexibility, and permits the close quality control necessary to hold rejects below 0.5%.

Have you a furnace problem like this?

To simplify construction of a refractory arch



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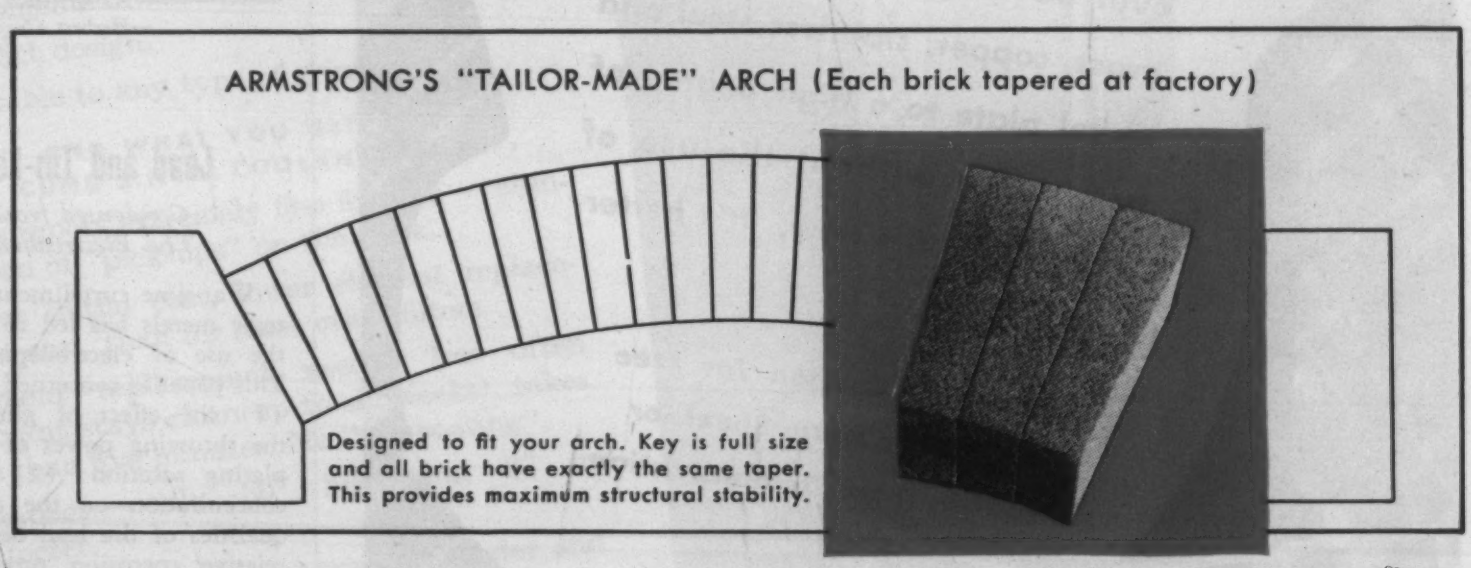
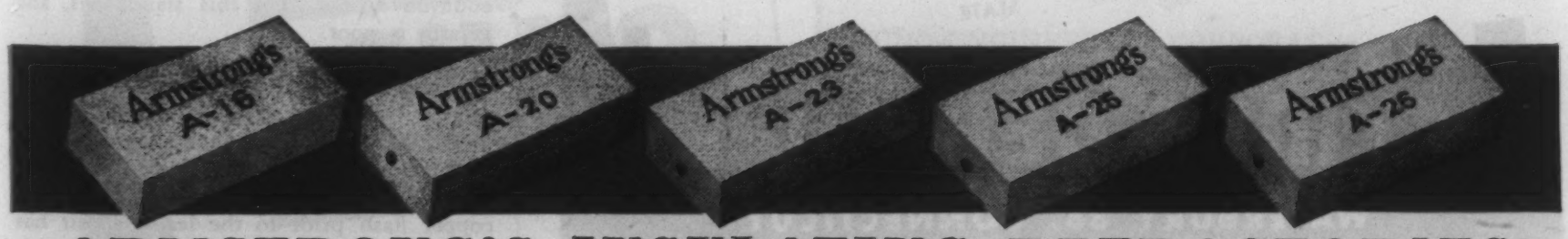


ORDINARY REFRACTORIES are seldom tapered to fit your furnace arch. The designer usually has to compromise on some combination of straights and wedges. This results in a less positive structure that takes more time to erect. The problem has been solved by Armstrong's "tailor-made" arch construction.

When you order, specify the span, rise, and length. Brick will be precision machined at the factory to exactly the right size and taper for your job, so that each brick "keys" securely with all the others. The large ends are positively identified with a colored dot to save time on the job. The brick are cut from standard units and cost no more than standard wedge brick.

These tailor-made arches are available in all five types of Armstrong's Insulating Fire Brick for temperatures from 1600° to 2600° F.

For full information, write today to Armstrong Cork Company, Insulating Refractories Department, 5506 Mulberry Street, Lancaster, Pennsylvania.



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METEX *Burnishing Compound* **No. 15**

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CITY ..... STATE .....

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The speed of the conveyor and the quantity of heat supplied to the oven can be varied so that a variety of metal and plastics parts can be handled.

The normal circuit for ferrous and zinc die castings parts is through cleaning, Bonderizing, hot water spray, chromic acid spray and dry-off to paint spray booth. Plastics parts are sent directly to the paint booth.

A spray gun using a standard synthetic wrinkle enamel is used for nearly all parts. Volatile gases and excess paint spray are exhausted from the booth. The sprayed parts pass through a quiescent atmosphere to permit the enamel to set before baking in the oven. The conveyor passes through the length of the oven three times for a length of about 90 ft.

Heat for baking is provided by a standard Ross oil-fired heat exchanger capable of supplying one million Btu. per hr. Fans change the air four times a min., and thermostats control temperature to within about 10 F.

After baking, the parts travel about 100 ft. in room air in order to cool before unloading. It will be seen that the setup permits the use of many different types of materials and castings.

—Herbert Chase. *Iron Age*, Vol. 157, Feb. 14, 1946, pp. 53-55.

Lead and Tin-Lead Coatings

Condensed from a Paper of The Electrochemical Society

War-time curtailment of the use of strategic metals has led to a rapid increase in the use of electrodeposited lead coatings. This paper is concerned with the following: (1) the effect of glue concentration on the throwing power of the lead fluoborate plating solution: (2) the effect of glue concentration on the corrosion protective qualities of the lead deposit: and (3) the relative corrosion protection afforded by lead deposits as against lead-tin alloy deposits. All data were taken at room temperature using a 40 deg. Bé. lead fluoborate solution containing approximately 218 g./l. (29 oz./gal.) of lead.

Investigation reveals that a glue concentration of from 0.4 to 0.8 g./l. is beneficial to the throwing and covering power, in still plating, however, the racking of parts and the anode and cathode arrangement would be of greater importance.

Although most glues will give some increase in throwing power, some have a tendency to allow thin needles of lead to form at the cathode, not necessarily at the high current density points. In most cases the cheaper grades of glue are the better addition agents from this standpoint, and gelatin is poor.

Outdoor and spray exposure tests on lead and lead alloy deposits reveal that lead can be considered a good coating for the protection of steel, although it does not afford the absolute electrochemical protection given by zinc and cadmium. The use of a copper flash prior to the lead deposit has proven advantageous in some cases, but it appears more economical to obtain the same protection by increasing the thickness of the lead deposit.

WHAT TO LOOK FOR IN A Unit-Type Coolant Filter

1000 sq in. of filtering area to handle full flow... 30" high, 8" diameter... Only two flexible hose connections... element fits over screen spacer

1. Positive action, handling full flow and removing all abrasive and metallic particles which would cause surface imperfections.
2. Low cost: initial cost of filter and replacement cost of element.
3. Low maintenance cost: fewest and quickest replacements of element.
4. Compact design.
5. Adaptable to any type of grinder.

AND WHAT YOU GET WITH CUNO'S NEW COOLANT-KLEAN

1. Users report extremely fine finishes — elimination of "pick-ups" on the work.
2. Lower initial cost, lower element replacement cost, than for most other filters.
3. Element replacement needed less often (coolant stays clean up to six weeks), takes less than five minutes. No "pre-coating".
4. Compact — only 30" high and 8" in diameter.
5. Can be applied to any type of grinder and almost any machine using a coolant or cutting oil. No alteration of machine. No filter aid, no extra pump, electrical work, plumbing, valves or by-passes.

Get the micro-finishes you want . . . lengthen wheel life . . . and save filter installation and maintenance cost . . . by using COOLANT-KLEAN on individual machines. Send coupon for new Bulletin 3110.

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KEEP FLOW ON "GO" WITH

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Gentlemen: Please send information on your new COOLANT-KLEAN filter.

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Position.....

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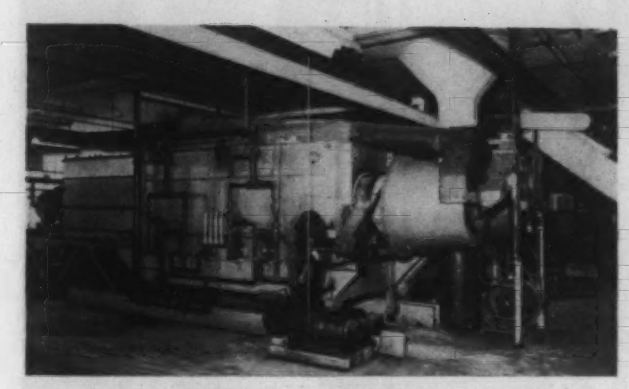
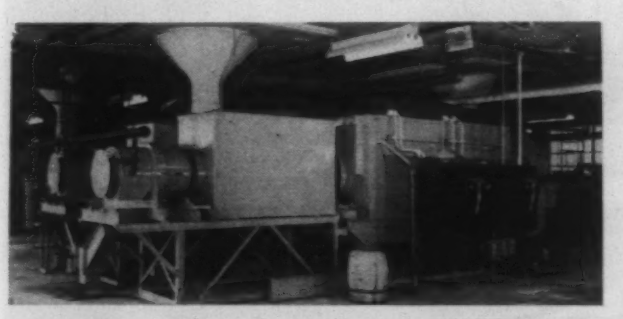
In ROCKWELL REVOLVING RETORT FURNACES

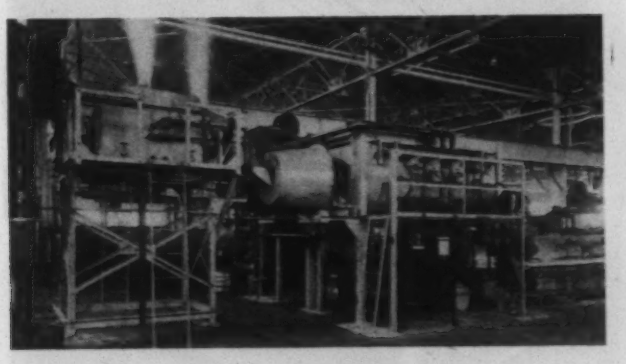
Continuous Bulk Heat Treating of Small Metal Parts Assures Uniform Quality and Saves Man Hours .....



Gas-fired revolving retort furnace for annealing stampings; showing automatic feed to rotary charging hopper, and the long cooling zone.



Electric revolving retort furnace for annealing small pressed steel parts in a protective atmosphere; showing (in foreground) cooling zone with water sprays, and chute for feeding parts to floor below.



Gas-fired, twin furnace for annealing 5000 lbs. of brass per hour; rotary washing and rinsing machine automatically feeds stampings into furnace, whence work is discharged into rotary pickling machine.

Here's the most efficient heating equipment for annealing, bright annealing, hardening or drawing ferrous and non-ferrous metal pieces which may be slowly tumbled during heat treatment.

Bulk loading of the retort is convenient, eliminates continual charging attention and saves labor.

Control of speed of retort's rotation and constant changing of position of each piece expose the parts to uniform controlled heating at the same rate and for the same time.

The furnace can be tied in with preliminary cleaning or washing and drying machines and with subsequent quenching tanks, cooling chambers or rotary pickling machines in a continuous, entirely mechanical production system.

Furnaces may be gas, oil or electric and provided with any protective atmosphere; built in 3 standard retort sizes for capacities of 300 to 1800 lbs. of metal per hour; also special sizes.

Write for New Bulletin No. 424.

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ROCKWELL FURNACES

Batch or Continuous Types—Gas • Oil • Electric

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Experimentation on the effect of the tin content of the deposit on its corrosion resistance demonstrated the following: (1) There is a gradual increase in corrosion resistance as the tin content increases up to 5.5%. (2) The 5.5% tin alloy is superior to pure lead. (3) The 5.5% tin alloy is better than the 7, 10 and 15% tin alloys. (4) The 10 and 15% tin alloys are comparable with a 100% tin deposit from an acid sulphate bath.

Pure lead deposits are gray and uniform in appearance after rinsing, but become stained and non-uniform in color upon drying. About 2% tin in the deposit is enough to give a more pleasing or lighter color to the deposit, which dries without discoloring. After a few weeks of outdoor exposure, pure lead deposits take on a light and dark mottled appearance, whereas the alloy deposits take on a more pleasing, dark, uniform color.

—A. H. Du Rose. *Electrochemical Soc.*, Preprint No. 89-7, Apr. 1946, meeting, 12 pp.

Moisture on Welding Rods

Condensed from "Schweizer Archiv fur angew. Wiss. and Technik"

The importance of the materials used in electrode coatings is described in detail by enumerating and classifying them. Their heats of reaction are given and ternary diagrams used to show the best range for solid beads for one rod coating containing magnetite, silica, and low carbon iron-manganese and another containing fluor spar, calcite, and 85% iron-manganese.

Four series of tests were made to investigate the influence of moisture on the performance of the coating. The increase of moisture content with time by (1) storing in air of 90% humidity, by (2) subjecting to a water spray, and by (3) storing in water is plotted.

Comprehensive tests are reported that compare the dry electrodes with electrodes submerged in water for 72 hours and kept in wet wrappings until used. No fundamental difference between dry and wet electrodes was found in the tensile, bending, bend-over and impact tests. X-rays showed increased porosity without direct correlation to the other tests. Allweld pieces were made for fatigue tests.

The results were very erratic with dry electrodes but rather uniform with the wet ones, the latter ones being definitely inferior in this series. Interstitial hydrogen is suspected to cause the lowering of the fatigue strength.

Composition of Test Coatings

	A	B	C	D
Free moisture	0.33	.66	1.19	1.02
Loss on ignition	9.45	2.65	14.2	12.6
SiO_2	23.2	31.2	20.3	11.7
Fe_2O_3	13.3	39.3	13.1	17.1
Mn_3O_4	8.94	21.2	7.8	9.14

—H. Stager & F. Held. *Schweizer Archiv f. angew. Wiss. & Technik*, Vol. 11, Dec. 1945, pp. 361-385.

Now Available in { 5 TRANSFORMER SIZES / 5 THROAT DEPTHS

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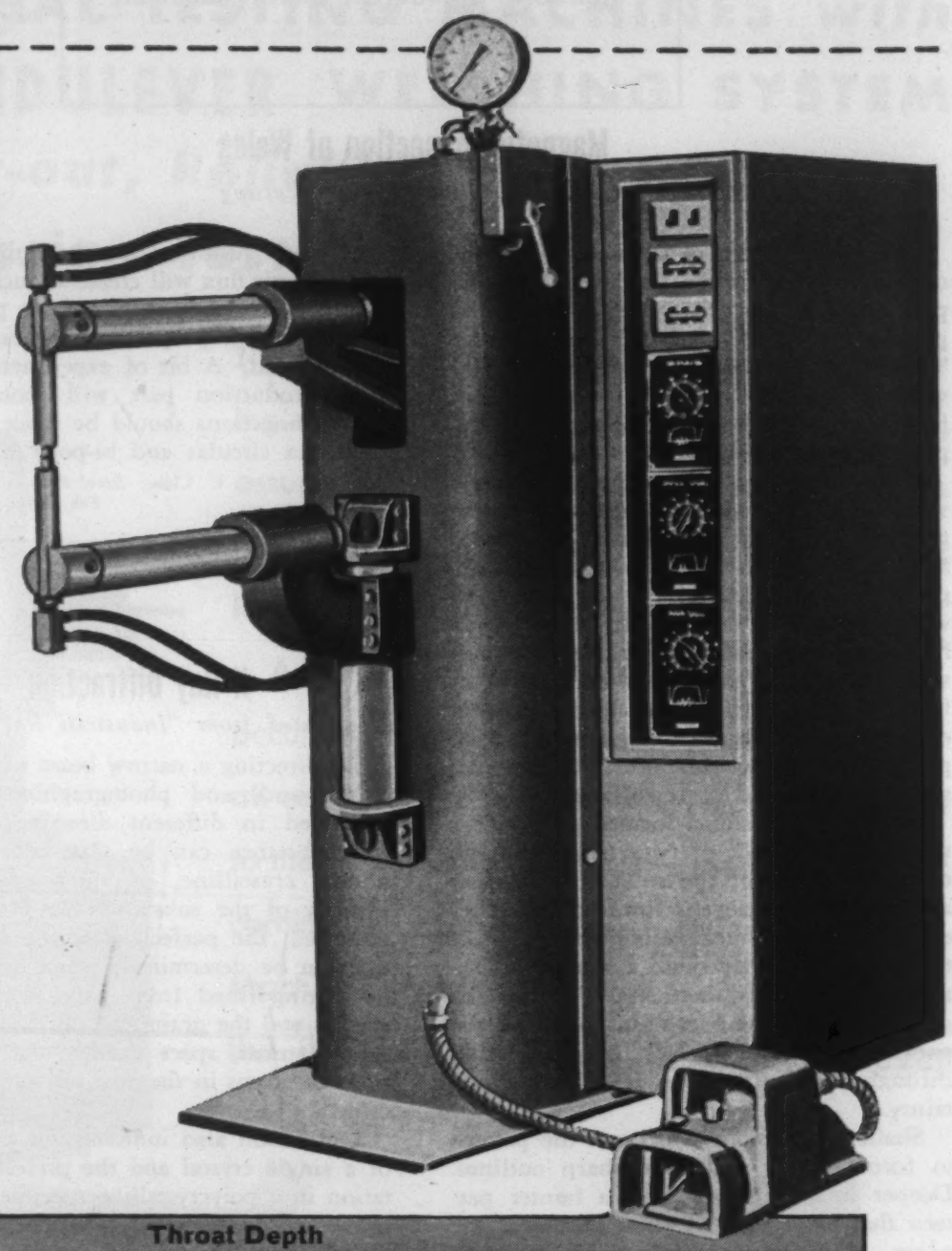

Popularity has demanded it! The versatility of this precision welder has been increased by providing a choice of 5 power ratings and 5 arm lengths. You can now choose a machine *tailored* to your fabricating problems—yet *low in price.*

Features usually found only on larger welders are incorporated. Operation is entirely automatic with electronic controls mounted in hinged cabinet convenient to operator. Air-operated rocker arm is provided with retraction stroke and moves on heavy duty roller bearings. Write for bulletin 112-D.

The chart below gives maximum capacities on clean, mild steel under the various KVA and throat depth conditions. Minimum weldable gauge is 28. (U. S. Standard)

Transformer Rating	Throat Depth 12"	18"	24"	30"	36"
20 KVA	16 Gauge	18 Gauge	19 Gauge	22 Gauge	Not Supplied
30 KVA	14 Gauge	16 Gauge	18 Gauge	19 Gauge	22 Gauge
40 KVA	13 Gauge	14 Gauge	16 Gauge	18 Gauge	19 Gauge
50 KVA	12 Gauge	13 Gauge	14 Gauge	16 Gauge	18 Gauge
75 KVA	11 Gauge	12 Gauge	13 Gauge	14 Gauge	16 Gauge

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Magnetic Inspection of Welds

Condensed from "Steel Processing"

The entire success of magnetic inspection of welds depends upon the ability to interpret correctly the patterns of the magnetic powder in terms of fault characteristics. The roughness and irregularities of the weld bead surface will distort the magnetic field so as to produce many spurious powder patterns where there are no actual faults.

The powder pattern formed over areas where there is lack of penetration at the root of the weld will be thin and feathered near the edge. Its size and shape will approximate a projection of the underlying void. It will be evenly distributed, while false patterns caused by surface roughness will be wavy. When a dark pattern is formed on an area, apparently independent of the extent of surface roughness, lack of penetration is probably present. The part should be X-rayed or reworked.

The powder pattern formed over cracks resulting from lack of penetration through the fusion zone of the weld will be clear and sharp in outline. However, a feather edge of unfused metal along the "toe" of the weld crater may cause a similar indication. All the feather edges should be ground off and the part re-inspected. If the pattern is reformed, lack of penetration through the fusion zone is almost a certainty.

Shallow inclusions will cause the pattern to form rapidly and have sharp outlines. Deeper inclusions will give a fainter pattern that tends to be feather thin near the edges. If inclusions are suspected, the immediate area should be ground smooth and the part re-inspected. Reformation of the pattern in the same area definitely establishes an inclusion.

The powder patterns over cracks caused by stresses, heat checking and manual errors during welding are sharp, of perceptible height, and follow closely along the open mouth of the crack. When such an indication is observed, the pattern should be wiped away and the area examined closely. If no cracks are visible to the eye, the area should be ground smooth and the part re-inspected. If the pattern reforms, the part should be reworked.

Powder patterns caused by the difference in permeability between the weld metal and base metal usually appear along the edge of the weld in the same area where indications denoting lack of fusion are likely to appear. When such indications do appear, and reappear after grinding, the part should be X-rayed or reworked.

A fault running transverse to the flow of magnetic flux will create a much stronger external influence than a fault paralleling the flux, with proportionally heavier powder patterns. A bit of experimenting with each production part will soon indicate how connections should be made to secure optimum circular and bi-polar magnetism.

—G. C. Close. *Steel Processing*, Vol. 32, Feb. 1946, pp. 122-125.

X-Ray Diffraction

Condensed from "Industrial Radiography"

By directing a narrow beam of X-rays at a substance and photographing the rays diffracted in different directions from it, the substance can be classified as amorphous, crystalline, or intermediate. The identity of the substance can often be established; the perfection of the crystal lattice can be determined; single crystals can be distinguished from polycrystalline substances and the grain size can be estimated; space lattices, space groups and the positions of atoms in the unit cell can be determined.

Diffraction also indicates the orientation of a single crystal and the preferred orientation in a polycrystalline specimen. Qualitative and in some cases quantitative measurements of residual and applied stresses, information on the effect on the lattice of plastic deformation, of heat treatments, age hardening and precipitation and the constitution of organic and inorganic systems can be learned from diffraction patterns.

For questions involving the identity of crystalline materials, X-ray diffraction is our most powerful research tool. The intensities of the patterns from each substance will be directly related to the relative amounts of the substances present in the sample, allowing for at least semi-quantitative determination. One can identify materials by referring to a card index system compiled by the American Society for Testing Materials.

The method is widely used for identification of the phases in alloys, being direct and positive. The study of the complex chemistry of boiler scales, turbine blade deposits and water softening is a typical example of application.

The method does not apply to amorphous solids, liquids or gases, for these do not yield sharp diffraction lines. It is inferior when one of the phases is present in amounts too small to show well in the diffraction pattern—say 1 to 5% of the sample.

This X-ray method also provides a strain gage in which a reading for zero strain is not taken but is provided automatically by the calculations. X-rays provide the only way of determining residual stresses without destructively cutting up the object and it is the only means of determining the residual stresses in the layers at the extreme surface.

Frequent use is made of this method to measure stresses in small castings, and as a control on the stress relieving operations. One of the great advantages is the speed of the method. Often the answer is available in two hours instead of two days, as with wire strain gages.

Micrographs made by this technique clearly show the difference between metals that are strain hardened by cold-working and those rendered stress-free by an annealing that produces recrystallization.

—C. S. Barrett. *Ind. Radiography*, Vol. 4, Winter 1945-46, pp. 12-18.

Electronic Testing

Condensed from "Iron and Steel"

A magnetic sorting bridge has been developed to control the uniformity of similar ferromagnetic materials. This method is based upon a comparison of the hysteresis properties with a standard and upon the fact that the shape of the hysteresis loop varies with the mechanical properties and composition of the material. The sensitivity can be adjusted as desired.

An automatic machine enables the rapid and accurate location of cracks. It is based on the fact that high frequency alternating current flows only in the outer skin of a conductor. If a conductor is passed through the inductance of an oscillatory circuit, eddy currents are induced in the surface at right angles to the axis.

If the frequency is chosen so the current is slightly deeper than the deepest crack, the effect will be to provide a short circuited turn. If the oscillator frequency is measured in a crackless sample (low resistance short circuited turn), then the frequency drops if a cracked sample is tested (increase in oscillator inductance).

The machine is arranged to give the depth of the crack, although the calibration depends upon the type of material being tested. Cracks within the range 0.001 to 0.250 in. are indicated. The upper limit of accuracy is determined by the smoothness of the bar surface.

A thickness meter is made to measure the thickness of nonmagnetic coatings on iron and steel. The coatings form a gap in the magnetic circuit of a small transformer contained in the exploring head. The meter can be calibrated in terms of thickness of the coating, although the calibration is different for nonmetallic coatings and for coatings of the various nonmagnetic metals.

The meter is very sensitive and will indicate very small variations in thickness. The usual meters will measure 0.001 to 0.022

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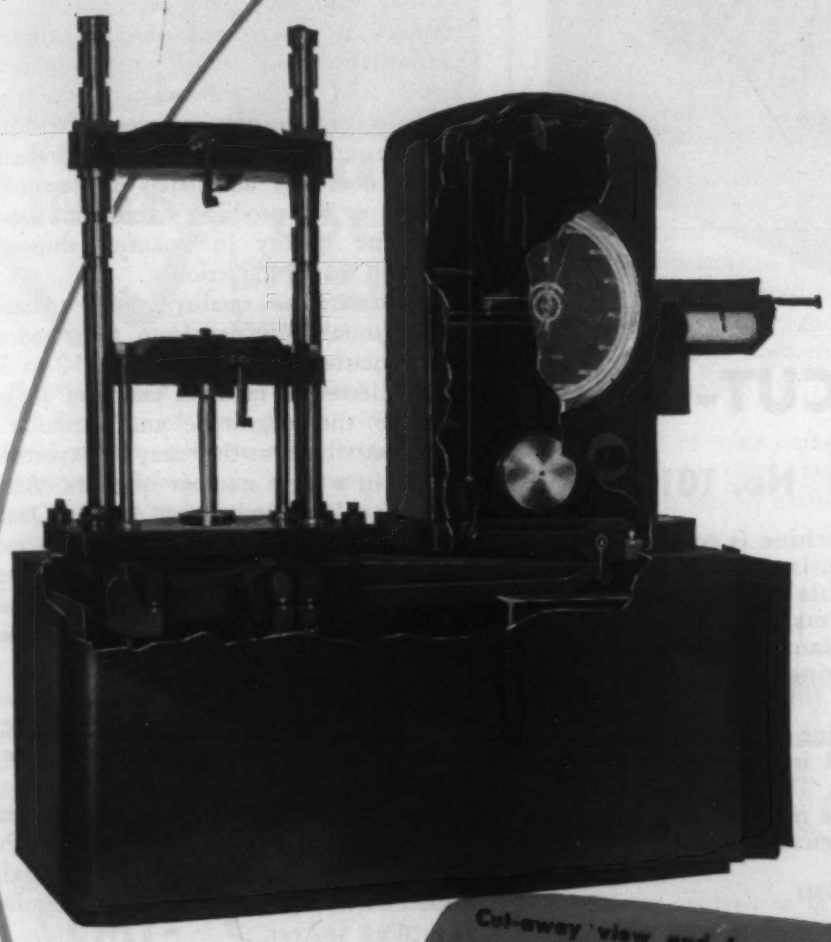
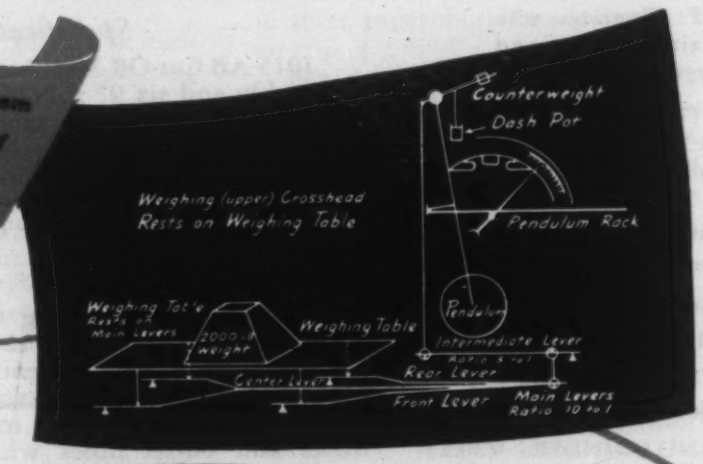


The positive, simple nature of the Olsen weighing mechanism, utilizing levers and pendulum, assures sensitive, true transmission of loads in tension and compression testing, whether that load is applied mechanically or hydraulically.

Accuracy in itself is desirable, but reliable accuracy over long periods of service, under all conditions is the ultimate. Tests, if they are to mean anything, must carry the assurance of continued accuracy. Olsen Universal Testing Machines give that assurance—beginning with the inherently efficient Olsen Pendulever weighing system.

Cut-away view and force diagram show graphically the base simplicity which has made Olsen Universals the accepted standard of accuracy.



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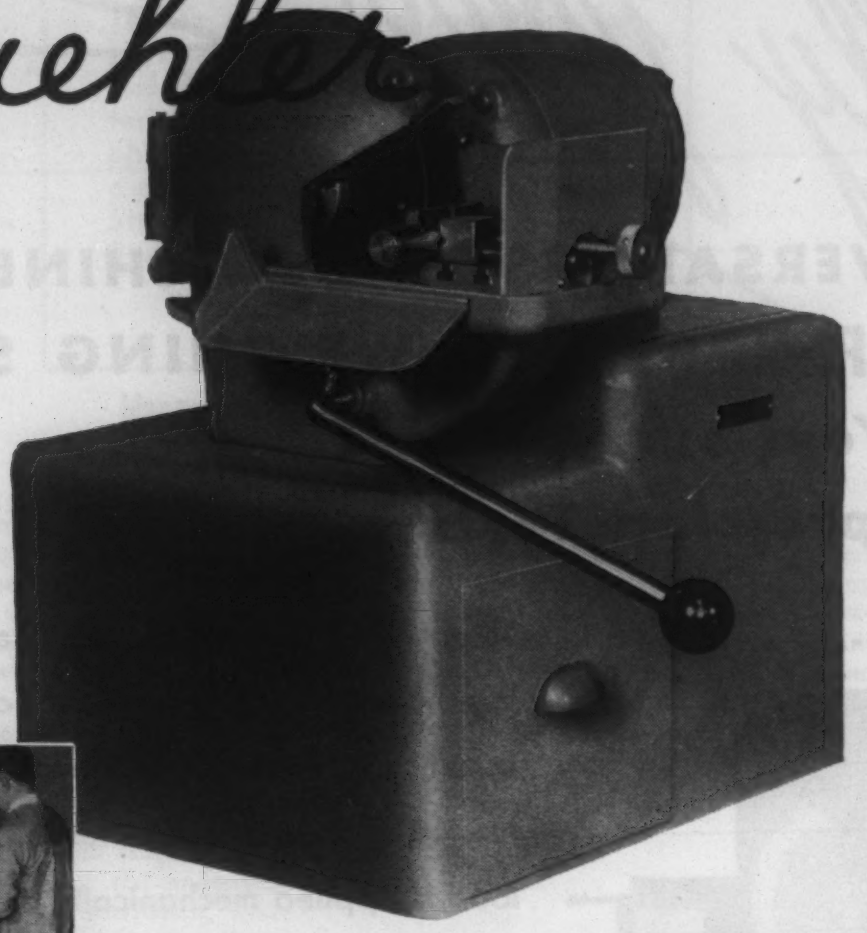

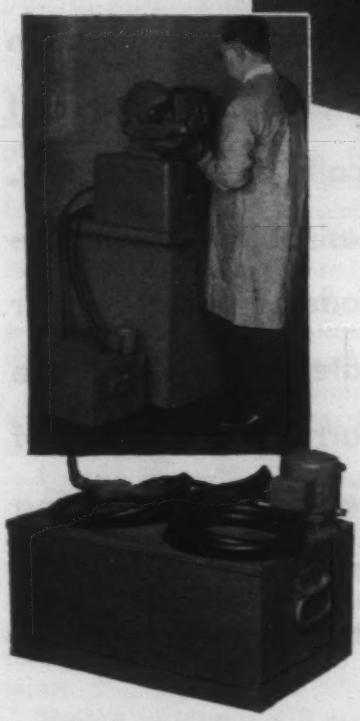

TOP: Operates with maximum ease and convenience.

BOTTOM: No. 1016 AB recirculating cooling system.

The BUEHLER line of specimen preparation equipment includes

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ABRASIVE CUT-OFF MACHINE No. 1015

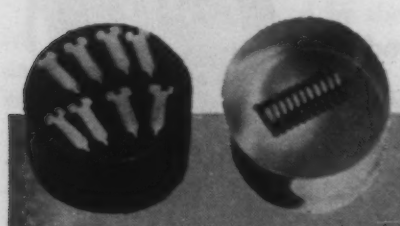
This new 1 h.p. cut-off machine is constructed with the usual Buehler emphasis on precision and ease of operation. It is a table mounted model, similar in design and performance to the larger cabinet model No. 1010. Coolant is supplied by a recirculating system comprising No. 1016 tank and hose connections.

This efficient cut-off machine occupies a minimum of space, is economical in cost, and has a capacity for cutting 1″ stock. The No. 1015 cutter promises to be one of the most popular cut-off machines in the metallurgical field.

Specifications

1015 AB Cut-Off Machine, complete with wheel assembly and six 9″ x 1/16″ x 1¼″ assorted cutting wheels, specimen table and vise. Motor 1 h.p. 220/440 volt, 60 cycles, AC, 3 phase, 3450 RPM, with electrical control. Complete with sludge trap of heavy pressed steel, with drawer and drain connections for cooling device. Directions included.....$275.00
Dimension 32″ x 32″ x 27″. Shipping wt., 260 lbs.

1016 AB Recirculating Cooling System with heavy tank 19½″ long x 12⅝″ wide x 9¾″ high divided into compartments with handles and cover with 1/30 h.p. 110 volts, 60 cycles, 1 phase motor directly connected to pump including intake and outlet hoses with control valve for 1015 Cutter.....$60.00
Dimensions 21″ x 14″ x 19″. Shipping wt., 40 lbs.



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or 0.005 to 0.030 in. coating thicknesses.

Another meter is made to measure the thickness of metals from one side only. An oscillating crystal is held against the surface of the metal. At the resonant frequency of the material, the crystal is damped and may be caused to give an indication on the meter. It is especially suitable for measuring the thickness of tank walls, boiler shells, pipe lines and cable sheathes.

—*Iron & Steel*, Vol. 19, Mar. 1946, pp. 119-120.

How Quality Engineering Helps the Purchasing Agent

Condensed from "Purchasing"

The methods of cooperation between the Quality Engineer and Purchasing Agent are dependent upon certain concepts of quality. Quality resultant upon acceptability of a product is determined through uniform performance tests, which are made under actual and extended service conditions. Often the single unit samples presented to the Design Engineer by the Purchasing Agent does not adequately represent the product or the producer's ability to deliver the same quality in quantity shipments based on mass production.

To determine quality, the Purchasing Agent should procure from the vendor a representative sample of about 250 to 350 units selected at random, enabling an estimate of the magnitude and variation of certain attributes as they may be expected to appear in a large number of units. Action between the Purchasing Agent, Quality Engineer, and the vendor effects a more satisfactory delivery; the vendor gains confidence in his customer, the bargaining position of the Purchasing Agent is improved and the cost-per-good-unit is reduced.

Another phase of cooperation between the activities of the Purchasing Agent and Quality Engineer is the investigation of practical tolerances. Through such investigation by the Quality Engineer, the Purchasing Agent has been aided by relaxing unnecessarily tight tolerances and permitted reductions in cost.

Sometimes the Purchasing Agent encounters a vendor who delivers satisfactory initial shipments, but whose product subsequently loses quality, requiring rejections in large volume. This situation has been remedied when the cause of the trouble has been revealed to the vendor through investigation by the Quality Engineer, aiding all concerned by producing a more desirable product, usually at a lower cost.

A quality engineering department maintains accurate and comprehensive vendor histories to prevent, as far as possible, the placing of a critical order with an unreliable firm. In the postwar era, as competitive selling supplants competitive purchasing, there will be urgent need for correlating all available engineering information. The Quality Engineer can help in ascertaining the right quality, and this service should be available in the phase of planning and negotiation as well as in the phase of actual procurement.

—Eugene Goddess. *Purchasing*, Vol. 20, Mar. 1946, p. 88.

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REFRACTORY COATING

FLINT HARD WHEN COLD

Brickseal becomes flint hard as it cools — protects walls from damage.

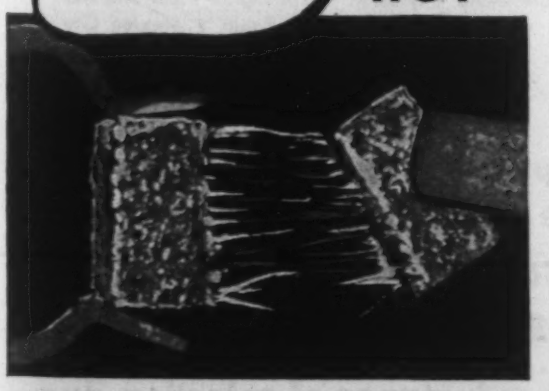
APPLIED LIKE PAINT—Brickseal, a combination of high fusion clays and metal oxides, protects refractories . . . preserves brickwork . . . prevents cracking, spalling and flame abrasion.

When heated, Brickseal deeply penetrates the pores and joints of the bricks and forms a highly glazed ceramic coating for refractory walls.

Brickseal is also used as a bonding material; it produces a tight brick-to-brick joint and welds the wall into one solid unit. Write for illustrated booklet; ask for a demonstration.

Brickseal is semi-plastic when hot allowing it to expand and contract with the furnace

SEMI-PLASTIC WHEN HOT



BRICKSEAL

REFRACTORY COATING

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1029 Clinton St., Hoboken, N. J.

BOOK REVIEWS

Surface Active Agents

SURFACE ACTIVE AGENTS. *By C. B. F. Young & K. W. Coons. Published by Chemical Publishing Co., Inc., Brooklyn, N. Y., 1946. Cloth, 5¾ x 8¾ in., 381 pages. Price $6.00.*

Wetting agents and how they act are discussed from the theoretical point of view. A 37-page list of trade names, type compositions, manufacturers, and suggested uses is really helpful for reference.

The utility of the second part of the book, that on applications, is less apparent. The preface states that it is not expected that the specialist will gain much from the discussion of his specialty, but may get something from study of the other sections.

Sections dealing with metal problems are on flotation, cutting and soluble oils, lubrication, and soldering, brazing, and welding. These are so condensed and, in some particulars, so poorly phrased, as to verge on the misleading now and then. Despite the preface, the sections on textiles, foods, and cosmetics appear to shed very little light on the metallurgical problems.

The list of trade names is worth at least a part of the price, but the last half of the book is not so useful.

—H. W. GILLETT

X-Ray Metallography

AN INTRODUCTION TO X-RAY METALLOGRAPHY. *By A. Taylor. Published by John Wiley & Sons, Inc., New York, 1945. Cloth, 6¼ x 9¾ in., 400 pages. Price $7.50.*

"X-ray analysis is now playing a leading part in the physical examination of metals," Dr. Taylor states, and there is need for an introductory book on X-ray metallography for metallurgists, which sorts out some of the "relevant information from a vast literature written by experts for experts." His book stresses the principles and methods of X-ray analysis, and includes an example or two of the results obtained with each of the various X-ray methods covered.

The author concentrates on a clear exposition of a limited range of subjects in a style suitable for classroom use, giving mathematical derivations when they are not too long, but omitting the more involved aspects of X-ray analysis, such as Fourier synthesis, the reciprocal lattice, and moving film cameras.

Some references are included regarding the results of research in the various metallurgical fields in which X-rays have been the leading tool, but the summaries of these results are quite brief and the references listed are few, and predominantly to English journals.

Discussions of the techniques of alloy diagram determination are very complete, as they should be, since Hume-Rothery and the other English scientists, including the author of the book, have made outstanding contributions to this field. There are much useful tabulated data included, such as the tables of X-ray data having to do with X-ray emmission, absorption and scattering, and tables of crystal structures of the elements and compounds.

Included also are chapters on space lattices, diffraction theory, diffraction methods and cameras, crystal structures of the metals, phase diagrams of binary and ternary alloys and their determination, grain size determination, grain orientation, the crystal structure of refractories, and radiography.

It is difficult for people to agree on the relative emphasis that should be given the different subjects in a book, as it is difficult to agree on tempo in music. It seems to the reviewer that the book much overemphasizes the subject of grain size determination (there are even large folded metallographic grain size charts tucked under a strap at the rear and a whole chapter on the subject). A disproportionate amount of space is also assigned to certain experiments of W. A. Wood on the structure of cold worked metal, while many other contributions to this subject, some of them more basic, are ignored.

It scarcely seems necessary to give space to Marsh's phase diagram nomenclature or to certain 1936 equations for stress measurement that are now replaced by more convenient ones. The business of having blank pages at the rear for the reader's notes is a matter of individual like or dislike, but to have these amount to about 10% of the paper in the book in these paper-short days is hardly necessary.

But these are details; looking at the book as a whole, the style is pleasing and effective, and the type, illustrations, and binding are good.

—CHARLES S. BARRETT

Other New Books

A. S. T. M. STANDARDS, 1945 SUPPLEMENT. PART I—METALS. PART II—NONMETALLIC MATERIALS (CONSTRUCTIONAL). PART III—NONMETALLIC MATERIALS (GENERAL). *Published by American Society for Testing Materials, Philadelphia, Pa., 1946. Cloth, 6 x 9 in., 395 pages, 250 pages, and 500 pages, respectively. Price $4.00 each part, all three parts $12.00.* Under the biennial plan of publication, these 1945 supplements to the Book of A. S. T. M. Standards, issued in 1944, are now available. Together with the Book of Standards they give in their latest form all of the Society's specifications and tests, excepting the chemical analysis of metals. Part I on Metals includes over 85 standards covering ferrous and nonferrous materials. Part II on Constructional Nonmetallic Materials has 50 standards, and Part III on General Nonmetallic Materials has 95 standards. The chemical analyses of metals are in a special volume.

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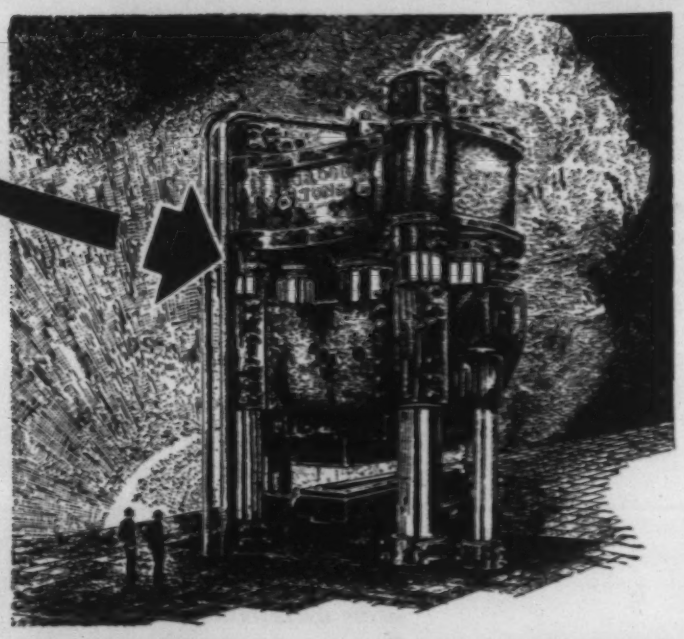

Looming on the horizon—the largest die forging press in the world, now in process of installation at Wyman-Gordon. When this press is completed at the end of this year, magnesium and high strength aluminum alloy forgings larger than any yet made will be available. This press will be operated by Wyman-Gordon Products Corporation, a wholly owned subsidiary of Wyman-Gordon Company for the account of Reconstruction Finance Corporation which owns the press, and will be available to aircraft manufacturers in particular and to industry generally for experimentation in and for the development and production of light metal forgings. This means to our aircraft industry reduced weight which, in turn, means increased pay-load and greater performance for American planes . . . And for industry in general—complete range of magnesium and aluminum forgings.

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This, the largest die forging press in the world, will make available larger magnesium and high strength aluminum alloy forgings than any yet made.

Wyman-Gordon Products Corporation selected four R-S Furnaces for the heat-treatment of work to be turned out by this mammoth press.

3 R-S Continuous Convection Type Forging Furnaces

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FURNACE DIVISION

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Manufacturing Engineers

New Materials and Equipment

Recent Developments in Engineering and Processing Materials

New engineering materials are being announced frequently these days. Some of them are brand new; others were developed several years ago, during the war, and are only now being released for general use. A number of these new materials are described briefly here. The material engineer who is searching for a new material to fill a particular product application or to solve some bothersome processing problem might find what he is looking for in this list.

Permanent Magnet Materials

A couple of months ago *General Electric Co.*, Schenectady, N. Y., unveiled five new permanent-magnet materials. They labeled them Cunico, Cunife, Vectolite, Alnico 12 and Silmanal.

Cunico magnets, an alloy of copper, nickel and cobalt, are made from rod, strip or wire stock. This material is machinable and ductile enough so that the manufacture of small magnet screws by screw machine methods as well as the punching of intricate magnet shapes is possible.

Cunife is a copper-nickel-iron alloy that has all the physical properties of Cunico. It has directional properties and must be magnetized only along the direction in which the material has been cold-worked, to obtain highest magnetic quality. These magnets are made from wire stock in round, square or rectangular form. In addition, Cunife wire can be flattened to make thin, narrow shapes. A variety of magnet designs can be obtained by forming, drawing, punching or machining the metal to shape.

Vectolite is probably the first nonmetallic, nonconducting magnet material ever made. It is a hardened, sintered combination of iron rust and cobalt oxide mixed when still in powder form. The magnets are relatively light; their nonconductive properties prevent electrical losses caused by conduction of current. In addition, they have a high coercive force, or resistance to demagnetizing forces.

Alnico 12 is made up of aluminum, nickel, cobalt, iron and titanium. Magnets made from this material can be used in such applications as in tachometer generators and electronic devices. Alnico 12 magnets are cast, and must be ground to shape.

Silmanal has a high intrinsic coercive force, which makes magnets made from this material useful in instruments where service in strong electrical fields is required. Silmanal is ductile and malleable and can be punched, machined, rolled, or ground.

Because of its ductility, Silmanal can be made in rod, strip or wire form.

High-Speed Tool Steel Development

Six years ago *Latrobe Electric Steel Co.*, Latrobe, Pa., began a research program to investigate the carbide segregation occurring near the center of high-speed steel bars and other shapes. This central concentration of free carbides is a non-uniformity and hence a source of weakness. It reduces the wear-resistant qualities of tools, causes warping and often results in tool breakage.

The Latrobe Company reports that through their research program they have developed a process (designated as "desegatizing") that achieves a more even distribution of free carbides throughout the steel. Thus, the elimination of carbide segregation at the center results in more uniform steel bars; it provides cutting tools with improved cutting and wear resistant qualities.

Nonmetallic Sheet and Insulating Materials

A new nonmetallic composite sheet has been developed by *Technical Plywoods*, Chicago. It is produced with closely spaced perforations in a plywood composite sheet about 0.050-in. thick, composed of two thin pieces of veneer as facings and a 0.010-in. layer of vulcanized fiber as the core. The fiber core permits perforating and otherwise cutting the sheet without breaking or splintering the thin wood faces.

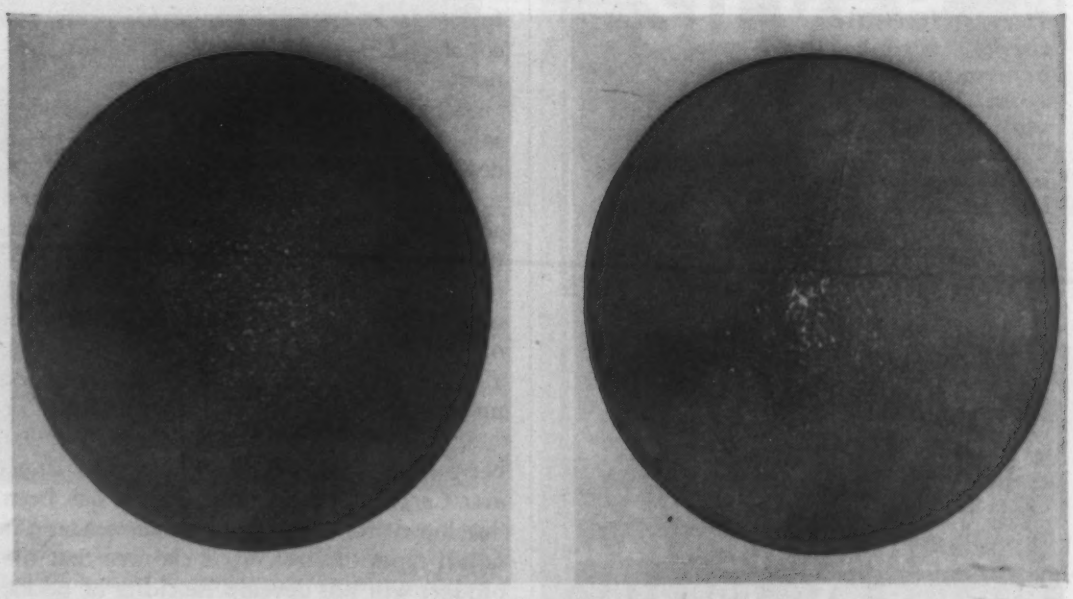
In the 0.050-in. thickness the material can be bent to approximately 2-in. radii, especially if slightly dampened before bending. It can be cut to form with an ordinary pair of paper-cutting shears, or with tinsnips; it can be stack-cut on power machinery with proportionate ease.

The woods used for facing are maple and mahogany, but plies of any wood may be substituted. Something of the natural beauty of the wood grain is retained in spite of the perforations, and may be enhanced by any of the usual finishing methods, such as staining, lacquering, varnishing, or polishing.

Originally developed for radio grilles, the material holds possibilities for the transportation industries, especially for aircraft, for grilles in connection with air conditioning installations, and for similar applications where passage of sound or air must be obtained through a protective screen.

Another composite now in preparation by the same company will consist of a 1/60-in. wood veneer applied over Masonite board, and scored to give a plank effect. While the chief use of the material will probably be in the building trade, it has advantages to offer in the construction of railroad lounge cars, diners, and in luxury interiors in marine and aeronautical construction, where its light weight and comparative freedom from dimensional change

(Continued on page 1684)



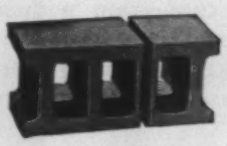
Polished and etched discs cut from two bars of high-speed steel: left, from standard bar; right, from "desegatized" bar.

FASTER CUTTING ...with Clipper Masonry Saws

Your Special Size and Shape Brick or Concrete Block can now be "Tailor-Made" at a moment's notice!

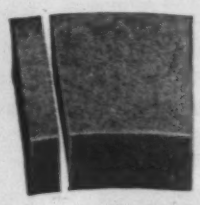
The new Clipper Multiple Cutting Principle makes possible faster cutting of every masonry material regardless of hardness.

Here are a few typical examples of the speed and accuracy with which concrete products and fire brick can be cut.



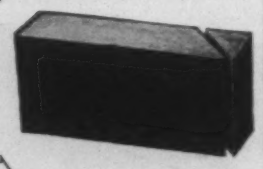
This concrete block, converted into a special size, was cut completely in two in 19 seconds.

One of the many intricate cuts performed on first quality clay brick for heat treating furnaces —made in 8 sec.



Rotary Kiln Blocks, cut to size for "key" bricks in rotary kilns, require only 10 sec. for completion of cut.

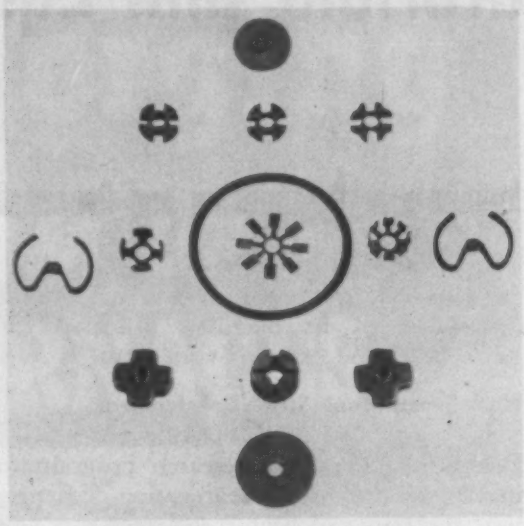
Basic refractories for steel furnaces or cement kilns must be accurately installed. This magnesite brick was cut in 12 seconds!



CLIPPER MFG. COMPANY
4037 Chouteau St. Louis 10, Mo.

are important. It has also been suggested for radios and similar pieces.

Glue is the principal raw material in a new type insulating board recently developed by *Foster D. Snell, Inc.*, Brooklyn 1. It weighs 1 to 3 lb. per cu. ft. The process of manufacture is simple and yields a board resistant to all destructive agencies. The board has fair strength although not enough to be used unsupported in structures. In thin layers the new product somewhat resembles flannel but as usually made it is more like dried natural sponge that has been cut into slabs a foot or so square and an inch thick.



Some complex shapes that can be formed from new magnetic materials.

By using different fillers, the characteristics of the product can be varied between wide limits, and the curing process imparts to the glue high resistance to water, fungi and other destructive agents. The product, called "Formboard", is suggested for insulating vehicles, railroad cars, trucks and airplanes wherever extreme lightness is required, together with efficient insulation against heat, cold or noise.

Cutting and Grinding Lubricants

From the research laboratories of the *National Oil Products Co.*, Harrison, N. J., comes the announcement of three new cutting oil bases for use in the metal-working field. One of these is an extreme pressure cutting oil base in which sulphur and chlorine are combined in noncorrosive form. It is applicable to steel, brass and copper cutting operations in which frictional loads are extremely high.

A sulphurized cutting oil base, and a soluble cutting oil base also have been developed. The former, containing 15% sulphur in both chemical combination and active form, is for straight cutting operations on ferrous metal. It is used by dilution or blending with low viscosity mineral oil. The latter, also soluble in mineral oil, is applicable where operations require a rapid removal of frictional heat developed under high loads in cutting operations.

A new water soluble grinding fluid has been announced by *Quaker Chemical Products Corp.*, Conchohocken, Pa. It has been developed for use in abrasive operations on all types of steel. It is claimed that the product will not develop rancidity or odors, even when mixed with very hard water or when used for grinding cast iron.

Compound to Protect Surface During Heat Treatment

This compound was developed by the *James H. Knapp Co.*, Los Angeles, to prevent oxidation and decarburization of metals being heat treated in temperatures ranging from 1200 F up to and including 2300 F. It can also be applied in the annealing operations on brass and copper. It has the important advantage of cleaning off easily, after quenching.

New Plastic for Molds

A rubber-like plastic for molds necessary in casting other plastics has been developed by *Duorite Plastic Industries*, Culver City, Calif. The material is a nonvulcanizable thermoplastic and can be reclaimed by melting without additives.

This plastic can be stretched; it bounces similar to rubber. One-piece molds can be made of the material to produce articles with back drafts and undercasts; the mold can be stretched when it is necessary to remove the castings. Known as "Duroflex", it is nonporous and can withstand temperatures up to 225 F without losing its desirable physical properties.

Air-Dry Rack Coating

A new air-dry rack coating developed specifically for the plating industry is announced by *Michigan Chrome & Chemical Co.*, Detroit 7. The new air-dry rack coating is a thermoplastic insulating material applicable to all plating, anodizing, tannerizing, parkerizing, and bonderizing cycles.

The coating, known as "Miccrotex", is said to be tough, resilient and flexible, and overcomes the difficulties commonly found in lacquers that have a tendency to become brittle with use, causing seepage under the coating and then peeling. It attains adhesion without depending upon shrinkage. Miccrotex is a black material with a high luster, unaffected by any solution commonly used in plating and anodizing cycles, including the electrolytic sulphuric acid strip used to dissolve bright nickel, and alkaline cleaners at boiling temperatures. The only exceptions are some of the organic solvents used in vapor degreasing. It is also very effective in minimizing dragout.

Miccrotex may be dipped, brushed or sprayed, depending upon the construction of the rack.

● A low temperature fire tube bath pot furnace capable of holding a narrow temperature control band is announced by *Don C. Campion Laboratories*, Detroit 4. These units are particularly adaptable for oil or salt-draw furnaces, stereotype and linotype work, tinning, babbiting, lead dipping and other operations up to 1200 F. The pot furnace is heated by burning the gas-air mixture in a fire tube submerged in the bath to be heated. This gives extreme sensitivity to temperature control by eliminating the thermal head common to refractory-line combustion chambers. The hot products of combustion envelop the exterior of the bath pot on their long way around to the exhaust port. This principle assures approximately 70% thermal efficiency.

New Mechanical Pickler

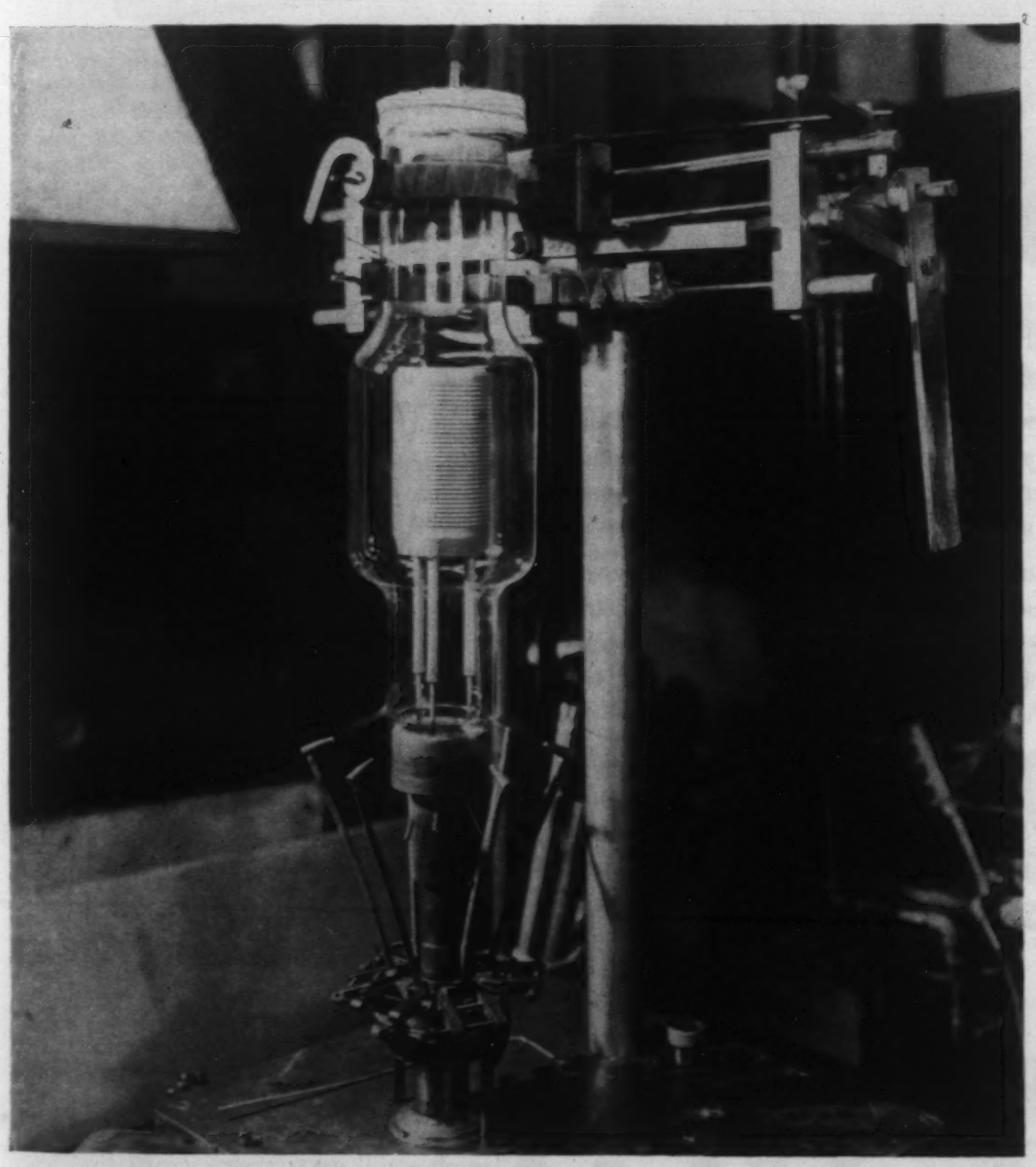
Pickling of steel bars can be usually accelerated by the practice of raising and lowering a sling full of bars in the pickle vat. This procedure causes the bars to move one against the other, cracking the oxide scale and aiding in its removal. Utilizing this principle, the *Youngstown Welding & Engineering Co.*, Youngstown, Ohio, has developed a new mechanical pickler which automatically raises and lowers five to ten tons of bars at a predetermined, continuous rate.

Operation of the mechanical pickler is simple. Two horizontal shafts at each side of the pickling tank are geared to a driving mechanism. Sheaves, fixed to the shafts, carry the chains. When the pickler is operating, the chains move; this causes rod bars and other stock being pickled to revolve against each other in the solution. In this way, all surfaces are exposed to action of the solution, and scale removal is speeded by the rubbing action.

When used for tubing, the pickler raises the tubes out of the solution and tilts them. Thus, the tubes are flushed out, providing a more vigorous pickling action on the inside surfaces of the tubes. The cycle of raising and lowering the shapes into the pickling solution can be regulated by simple adjustment, according to the requirements of the material being processed.

The pickler will handle a wide variety of shapes—bars, rounds, flats, squares, hexagons, and tubing. Chains and other exposed parts are made of alloy metals to provide strength for heavy loads, resistance to the severely corrosive action of the hot acid pickling solution, and resistance to wear.

Although the design of the "Weldco" pickler has been standardized, it is possible to fit this equipment into any type plant. It can be built to any capacity, and the only tonnage limitation is the limit of the individual company's handling equipment.



Sealing Glass Transmitting Tubes—*The above picture shows one of the important steps in the manufacture of transmitting tubes at the Brooklyn plant of Amperex Electronic Corp. A vertical lathe is employed to seal the anode assembly into the bulb of the transmitting tube. A small rubber hose at the top introduces inert gas into the bulb to keep the supports clean. Flames are played on the bottom portion of the bulb as it revolves to complete the sealing operation.*

R-C dual-ability

means better blower performance

R-C Centrifugal Blowers may be driven by steam turbine or direct connected motor—whichever is best fitted to the installation.

CENTRIFUGAL

R-C Centrifugal Blowers are available in a multitude of sizes of single or multi-stage design, in capacities up to whatever your needs may be.

ROTARY POSITIVE

Where the rotary positive displacement type is better adapted to your needs, no other company can meet the standards set up by R-C equipment . . . the leader in the field for almost a century.

You'll get profitable service from Roots-Connersville Centrifugal Blowers and Exhausters because:

1. Our engineers study your needs in detail before selecting type, speed, drive, number of stages, style of impellers, etc., to insure the unit best adapted to your special requirements.

2. Our plant builds the units with scrupulous care, to close tolerances, with fine machining and finish of the materials best fitted for the work. They check every part, and the final assembly is subjected to rigid tests, before shipment.

Proof of the practical value of this R-C *dual-ability* is found in the many installations of our Centrifugal Blowers and Exhausters. They're being successfully and profitably used in almost every industry. They live up to their guarantees and have unfailingly given excellent performance.

ROOTS-CONNERSVILLE BLOWER CORP.
One of the Dresser Industries
606 Superior Avenue, Connersville, Indiana

Roots CONNERSVILLE SINCE 1854

CENTRIFUGAL BLOWERS & EXHAUSTERS

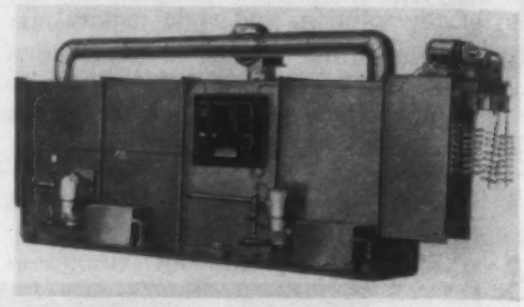
ROTARY POSITIVE AND CENTRIFUGAL BLOWERS • EXHAUSTERS • BOOSTERS
LIQUID AND VACUUM PUMPS • METERS • INERT GAS GENERATORS

New Metal Washing Machine

Optimus Equipment Co., Matawan, N. J., has introduced a new continuous type washing machine for cleaning metal parts before plating, painting or any similar process. It will handle any type of parts provided they are free-draining, and the sprays have free access to the parts. The parts to be cleaned are passed through the machine on racks. The output may be as high as 60 racks per hr.

This new machine can be used as a single stage washer, or it can handle a number of successive operations, alkaline, acid, or neutral. With slight alterations, this machine can take care of a series of different operations—washing, rinsing, drying, pickling, cyanide treatment, etc.

If an acid solution is used, the machine is furnished built of acid-proof material. In most cases, it is desirable to use it only as a washing and rinsing machine. Its



This continuous type washing machine is applicable to a variety of cleaning operations.

greatest use is for the cleaning of buffing compositions after buffing and before plating.

A number of manifolds with spraying nozzles are mounted on all sides of the washing chamber. Solution circulation system includes a pump, piping, series of filters and strainers to filter the solution before it is taken by the pump, and all necessary heating devices and accessories. The conveyor is an overhead chain type winding around two end sprockets driven by motor and speed reducer with variable speed pulley.

● A hand pyrometer for non-ferrous molten metal for simple and accurate temperature readings on a direct-reading type dial is announced by *Claud S. Gordon Co.* It is of cast aluminum and brass construction, designed for years of service, with a 43-in. stainless steel extension and a standard 7-in. Marshall tip which permits true readings to be taken below the surface of the metal. The indicator is of medium resistance, not affected by thermocouple length, and yet travels across the scale rapidly enough to follow the most sensitive thermocouple. It is provided with an Alnico V magnet and has a 3½-in. scale reading from 50 to 2500 F. It is always ready for use, needing no preliminary adjustments.

In Product and Method Research consider this *Versatile* Metal

When seeking the "ideal" metal to improve your products or methods, consider Carboloy Cemented Carbide.

Accepted as an excellent cutting material; indispensable in many types of dies, this versatile metal also has many *other* possibilities because it combines in the *one* metal *all* of these useful properties.

6 Unusual Qualities Combined in ONE Metal!

- High Red Hardness
- Extreme Density
- High Abrasion Resistance
- High Modulus of Elasticity
- High Compressive Strength
- Low Coefficient of Expansion and Contraction

26,000,000 FLASHLIGHT BATTERIES FROM *ONE* EXTRUSION DIE!

Extruding abrasive carbon rod is rough on dies! One manufacturer's Carboloy Dies produced 5,000,000 feet of rod, compared to steel's 75,000—that's 67 to 1 greater die life! Longer held die tolerances also gave cells more uniform electrical qualities.

TURNING WATCH PARTS WITHOUT ANNEALING

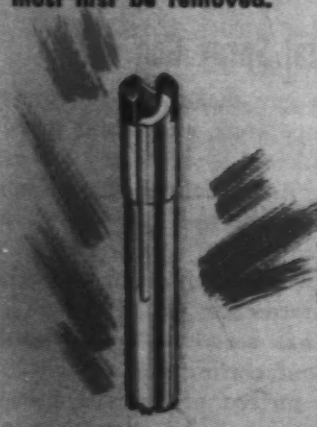
This solid Carboloy* watchmaker's graver cuts hardened watch parts. Ordinarily, with diamond cutters or sapphire strippers, burnish or temper must first be removed.

"OUNCE-SIZE" TEETH THAT TAKE 2-TON "BITES"

Carboloy Cemented Carbide "teeth" on these tongs insure safe lift-and-carry of 2½-ton steel billets; bite into tough metal with a bulldog grip; last for days, compared to hours for steel "teeth".

CUTTING CONTAINER COSTS

In making scored-top food cans with hinged lids, the rolls for scoring and hinging ordinarily require costly maintenance at frequent intervals. One plant solved the problem with Carboloy* rolls lasting 35 to 1 over steel!



DRILLING CASE HARDENED STEEL FOR TEST BARS

This Carboloy* tipped core drill trepans thick, case hardened steel, obtaining test bars for hardness measurement at any depth. Formerly, case depth could only be assumed by resistance to drilling from "soft" side.

TO SPEED YOUR IDEAS INTO METAL

Carboloy Cemented Carbides can be supplied in virtually any shape or size, for use wherever there's wear on product parts, or on tools and dies for cutting and forming.

CHICAGO — MILWAUKEE
CLEVELAND — NEWARK
DETROIT — PHILADELPHIA
HOUSTON — PITTSBURGH
LOS ANGELES — THOMASTON

CARBOLOY COMPANY, INC. 11161 E. 8 Mile Blvd., Detroit 32, Mich.

*CARBOLOY (TRADEMARK) CEMENTED CARBIDE

HARD METAL

. . . in this full-automatic plating cycle at GE

For pleasing brilliancy, corrosion protection and prevention of stains and fingermarks during assembly, without effect on electrical conductivity or solder-ability, General Electric chose Luster-on* bright dip for the speaker shells, chassis and other zinc-plated parts of its 1946 radio line.

To meet the needs of their full automatic plating equipment, our engineers developed the new *Conveyor Type* Luster-on* Acid — a specially buffered product to give the same fine results as regular Luster-on*, but with *6 — 7 times slower* action so as not to require mechanical delayed action transfers.

Conveyor Type Luster-on* is even more economical than that used in hand operated cycles — another powerful advantage.

If you use zinc-plating, you need Luster-on* — available now in *two* types, for hand or automatic use. Write for full details today. 12

THE CHEMICAL CORPORATION
54 Waltham Ave., Springfield 9, Mass.

Please send me full particulars about Luster-on* bright dip for zinc surfaces. I am (am not) sending sample part for free dip. No obligation, of course.

Name.....

Address.....

Materials and Methods, June

*Patent applied for

THE Chemical CORPORATION
54 Waltham Ave., Springfield 9, Mass.

New Rustproofing Technique for Steel

A new rustproofing technique for steel and galvanized steel, known as the "Banox" process, has been developed by *Calgon, Inc.*, Pittsburgh. It is designed to protect metal during the manufacturing stages and also to permit a tight bond with paints to enhance corrosion resistance.

The basis of this new chemical process is a glassy metal phosphate coating. The coating will bend with the steel or permit die-stamping. It has a thickness of from 5 to 15 millionths of an in.; it may be put on by the spray, immersion, or brush methods. The coating is inorganic and insoluble.

The process was first tried out in giving a protective pre-coating for painted steel shell containers during the war. Formerly, the humid, salt-laden atmosphere of the Pacific stripped paint along with vital identification from containers. In overcoming this, the Banox treatment was completely successful.

The process was further developed as an economical method for producing a protective phosphate coating on steel, zinc, and other metals and alloys. This coating process is applicable to the finishing of automobiles, refrigerators, ranges, stokers, and other household appliances.

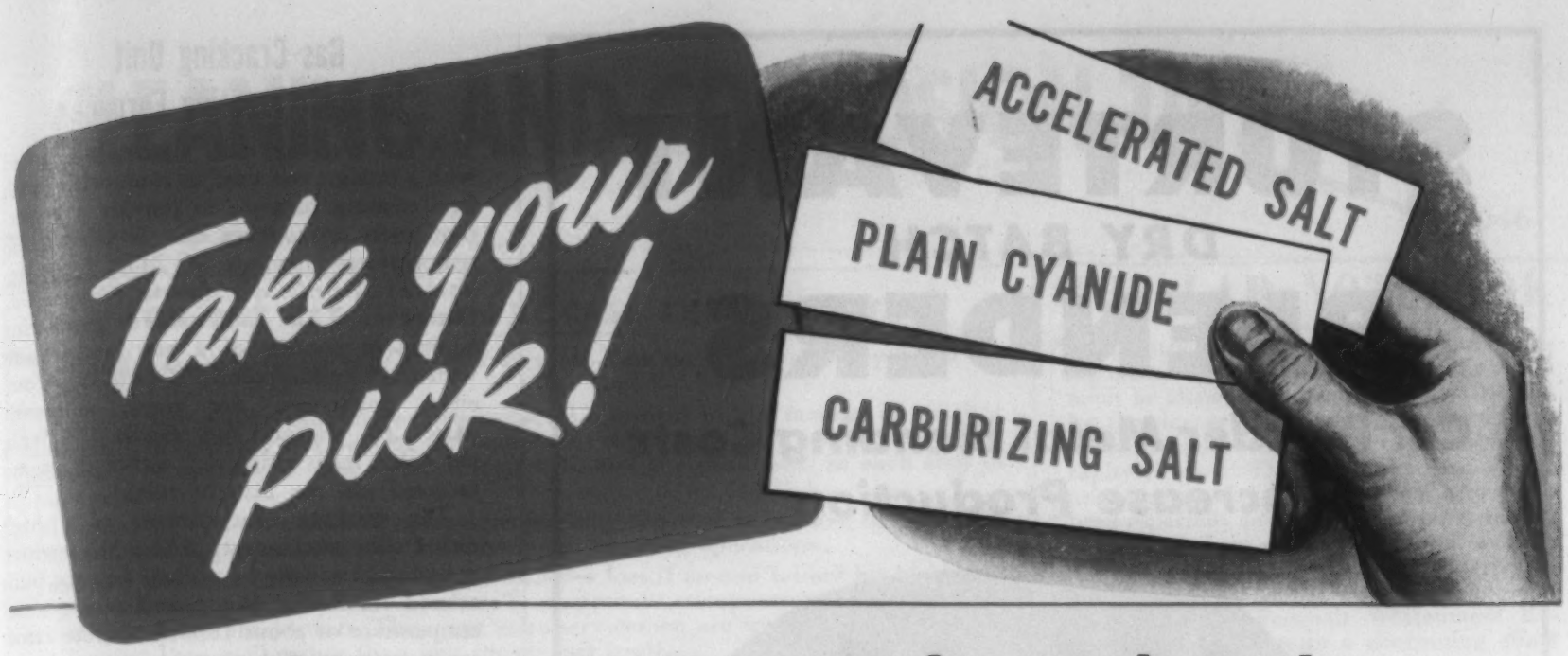
● A newly developed attachment that converts manually-operated metal cut-off saws to full automatic operations has been built by *Machine Specialties*, 4029 N. Kedzie Avenue, Chicago. The "Saw-Matic" consists of a pull-up device, a vise clamp mechanism, a saw lifting and lowering device, and a super-sensitive length control valve of special design. The unit will cut any length from 3/16 in. up, automatically. Consistency in length of cut to 0.010 in. is achieved by a special friction pull-up device and an especially sensitive valve, so that the last piece sawed is the same length as the first on production runs.

Metal Spray Gun

A metal spray gun that melts and sprays low melting temperature alloys and metals is now being marketed by the *Alloy Sprayer Co.*, New York. A self-contained precision type sprayer, it can be used for either intermittent or production spraying and is designed to provide close control of the amount and characteristic of the spray.

The sprayer has seen use in selenium rectifier cell manufacturing for applying a finely atomized surface of sprayed metal, as well as for coating wood patterns, production of molds (for lost wax process), making dies and molds, reproducing parts and producing molds for electroforming.

Because of the design of the stainless steel melting pot, intermittent spraying without emptying the pot during off periods is possible. Metal or alloys in stick form is inserted in the pot through the guide ring and feeds down as it melts. Metal and alloys can also be inserted in the gun by using ladle and funnel.



There's a Du Pont Molten Salt Bath for Any Type of Case Hardening

Case Depth Desired	Recommended Bath	Temp. °F	NaCN %	STARTING COMPOSITION	REPLENISHING COMPOSITION
0.003" to 0.010"	PLAIN CYANIDE	1400 to 1600	20-30	30 or 45% CYANIDE-CHLORIDE MIXTURE, "CYANEGG" and NaCl, and/or Na_2CO_3	45, 75 or 96% NaCN—depending on dragout loss
0.010" to 0.035"	DU PONT ACCELERATED SALT with Graphite Cover	1500 to 1650	18-22	ACCELERATED SALT or ⅓ HEAT TREATING SALT No. 6 plus ⅔ ACCELERATED SALT	ACCELERATED SALT
0.025" to 0.090"	DU PONT CARBURIZING SALT with Graphite Cover	1650 to 1750	8-12	⅓ CARBURIZING SALT plus ⅔ HEAT TREATING SALT No. 6	CARBURIZING SALT

EACH OF THESE BATHS is designed to produce cases of desired depth in the shortest possible time at the lowest possible cost. Yet they're but three of many Du Pont heat treating products that will return top production for you with maximum economy. Du Pont technical men will work with you in selecting the right materials to meet specific needs. For further details write: E. I. du Pont de Nemours & Co. (Inc.), Electrochemicals Department, Wilmington 98, Delaware.

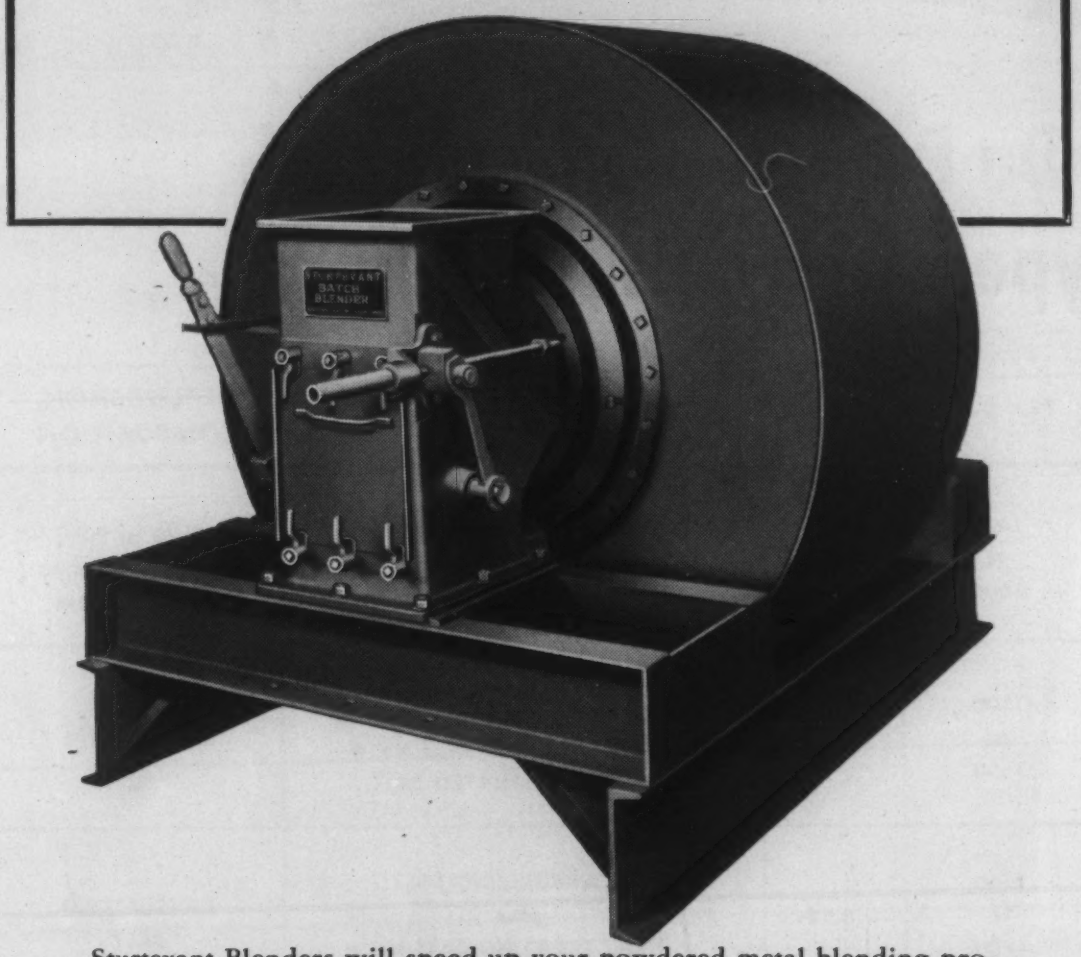
Listen to "CAVALCADE OF AMERICA."
Monday evenings, NBC

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

DU PONT CYANIDES and SALTS *for Steel Treating*

STURTEVANT
DRY BATCH
BLENDERS
Cut Powder Metal Blending Costs ... Increase Production



Sturtevant Blenders will speed up your powdered metal blending providing perfect homogenous blends regardless of the varying densities, weights or finenesses of the powders.

The 4-way mixing action assures perfect batches with no substances floating to remain unmixed. As materials are received they are picked up by revolving buckets and cascaded from the top of the machine. At the same time the drum revolves forcing the powders from both ends toward the center of the drum . . . while the swinging chute, which is in blending position produces a fourth lateral mixing action.

Heavy rugged construction assures long life. Open-door accessibility permits quick, easy cleaning. Available in sizes from 1000 to 7500 pounds. Write for information.

Sturtevant MILL COMPANY

61 Harrison Square • Boston 22, Massachusetts

Designers and Manufacturers of

CRUSHERS • GRINDERS • SEPARATORS • CONVEYORS
MECHANICAL DENS and EXCAVATORS • ELEVATORS • MIXERS

Gas Cracking Unit for Heat Treating Furnaces

A gas cracking unit, which is supplied with a catalyst and used in conjunction with heat treating furnaces to provide a protective, inert atmosphere that is effective in temperatures upwards of 2450 F, is announced by *Bellevue Industrial Furnace Co.*, Detroit 7. The atmosphere generating equipment consists of a gas cracker unit with all necessary controls, such as pyrometers, flowscopes, fire traps, automatic valves, etc. Natural fuel gas at 100 B.t.u. per cubic ft. is employed, although manufactured gas can also be used.

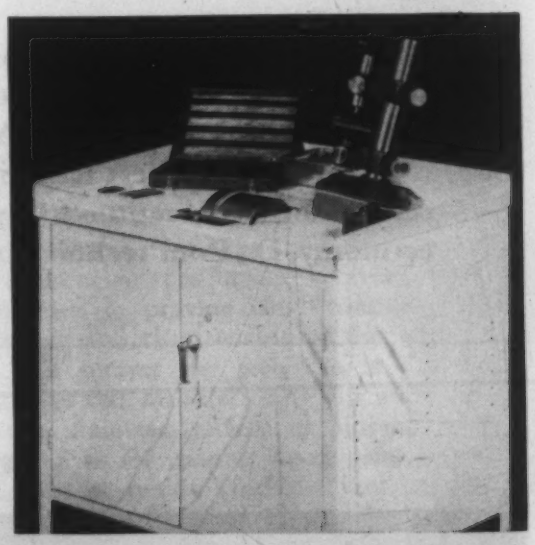
The cracking unit consists of a high nickel alloy steel retort (SAE 3515) which is heated externally by a small furnace built around it. Retort is operated at a normal temperature of about 1830 F. In the retort are a quantity of high-temperature porous refractory cubes which have previously been impregnated with a special catalyst.

● The *Ellanar Chemical Co.*, Chicago 6, has developed a new cold wire stripper for use on magnetic wire covered with plastic coatings and enamel. It can be used in place of the cruder methods using wire brushes, knives, and abrasive cloth.

Centerless Lapping Machine

Size Control Co., Chicago, has announced a lapping machine for the precision finishing of cylindrical pieces. A precision finish of less than 2 micro in. can be obtained on this machine.

The "Model 100" lapping machine is furnished with a set of lapping rolls ground for precision work, a vibrationless drive, a ½-h.p. motor, 110 volt a.c. installed, a set of three lapping sticks, a jar of lapping compound, and complete instructions for operation. The cabinet is complete with coolant tray and lock.



With this centerless lapping machine it is possible to obtain finishes of less than 2 micro in.

CLEANING AND CORROSION TIPS

Issue No. 3

JULY 1946

IT'S THE CLEANING PROCESS THAT COUNTS

You and I know a fellow may be well dressed—but he can't walk very far if his shoes don't fit.

Similarly, any good chemical cleaning material is limited by the manner in which it is used. I'm referring not only to the equipment itself, but, more specifically to the sequence of operations—the cycle, if you will, and the conditions in each step in the cycle.

The cleaning *cycle* is a *team* of operations working together to remove the obstacle, the soil, and to prepare the way for subsequent finishing operations.

Just as a powerful fullback may be thrown for a loss if an end misses his block—so a good cleaner will fail if its "blockers"—equipment, temperature, time, current, rinsing, etc., are inadequate. Thus, our sales servicemen are trained to think of the "Cleaning Process," rather than just the cleaner itself.

Wm. P. Drake
Manager of Sales
Pennsylvania Salt Manufacturing Co.

CASE NO. 704

Heat Treating, Quenching, and Cleaning Cycle Speed Increased 100%

A machine tool manufacturer had a rack conveyorized cycle of heat treating, quenching and cleaning for steel tool parts. The metallurgist was on the spot because the cleaning of oily salts from the parts was slowing up the whole process. He called on a Pennsalt man for help. After a complete investigation of the cycle, he recommended Pennsalt Cleaner No. 37. This quick acting, heavy duty cleaner cut the cleaning time in half . . . without increasing the number or size of the tanks.

This proved to be even faster than necessary for the heat treating and quenching phases of the cycle. Then a new method of racking the work was designed by the Pennsalt man and the metallurgist for maximum production efficiency of the conveyor system. Now heat treating, quenching and cleaning speed is up 100%—production costs are much lower.

CASE NO. 751

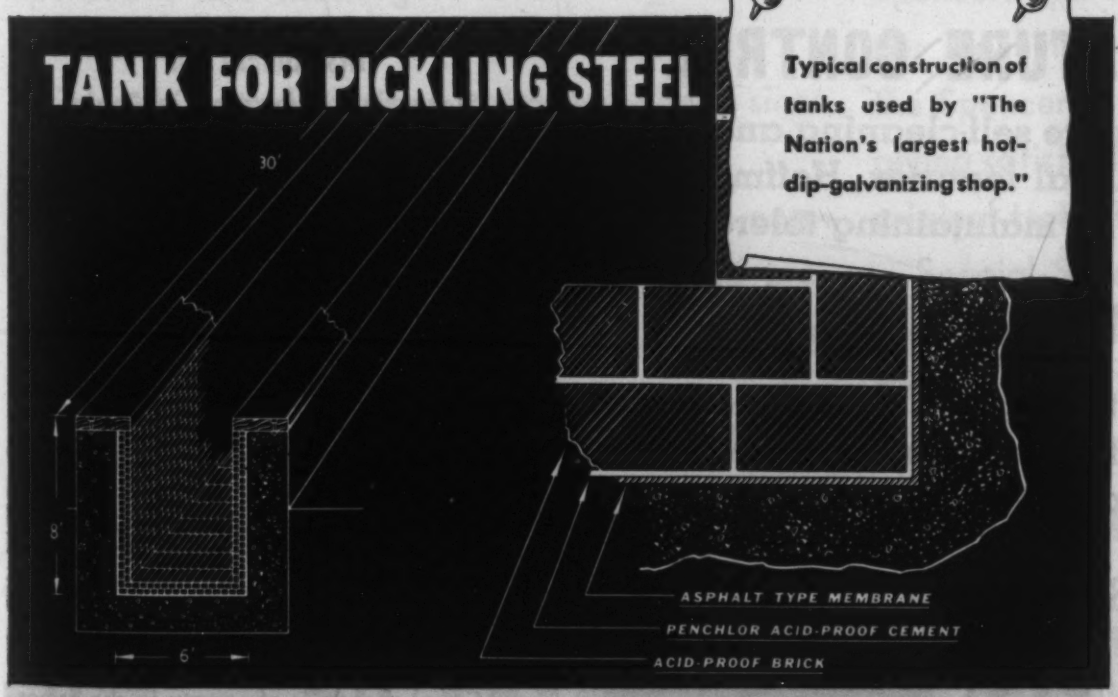
Large Motor Manufacturer Eliminates Bonderite Streaking

Cleaning equipment down-time cut from 5 hours to 25 minutes weekly

An all-automatic conveyorized system was being used to clean, bonderize, and paint sheet steel parts. In spite of the efficient equipment, the cleaning foreman was plagued by streaks on the bonderizing and subsequent poor paint finish. In addition, down-time for changing the screens in the cleaning tank was stopping production 5 hours weekly.

The Pennsalt man called in to solve this tough problem saw that major changes were needed in the cleaning operation. He recommended a solvent-alkali cleaning method consisting of Pennsalt #30 (Alkaline Cleaner) and Pennsalt EC #10 (Solvent Emulsion Cleaner), both of which could be used in the regular equipment. Production shut downs, due to clogged screens were practically eliminated. Bonderite streaking disappeared. The paint foreman reported, "We have never had a better paint job."

TANK FOR PICKLING STEEL

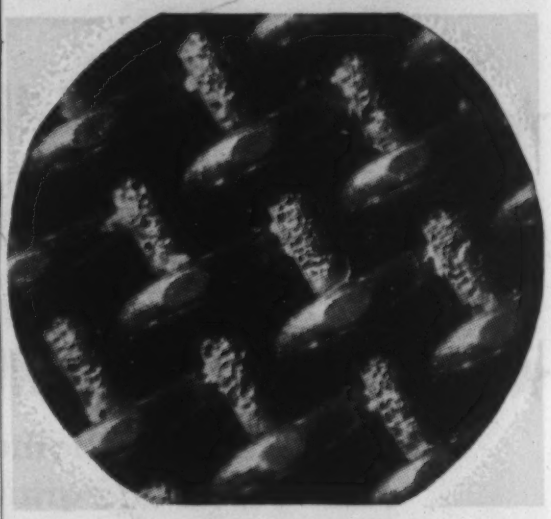


Typical construction of tanks used by "The Nation's largest hot-dip-galvanizing shop."

Tank lined with double course acid-brick, laid entirely with Penchlor Acid-Proof Cement, which gives thorough protection against severe corrosive action of 10% sulphuric acid at 180° F. and withstands the physical abuse resulting from submerging and withdrawing steel plates.

THE LAB NOTEBOOK

Frequently it is necessary to develop cleaning methods for customers wherein the metal must be chemically clean and not attacked by the cleaner. To determine if there is an attack and the amount of it, photomicrography is used. The photomicrograph of a fine copper wire screen shown below has been especially prepared (purposely etched) to indicate how even infinitesimal etching of metals by the cleaner can be detected. This is but one of the many methods employed by the Pennsalt Whitemarsh Research Laboratories in a continuing effort to develop better cleaning processes.



CASE NO. 769

Cleaning Foreman Helps Plant Engineer Lick Water Scale Problem

In a large industrial plant the heat exchanger of an air conditioning unit frequently lost its efficiency and required dismantling to remove hard water scale. Two to three days were required to remove the scale by manual chipping. At best, only a fair job could be done.

Because of the cleaning foreman's experience with cleaning metal chemically, the plant engineer asked for his advice on the problem. "Let's put it up to the Pennsalt man," suggested the cleaning foreman. Subsequently, Pennsalt PM-90 was put to the test. In less than 3 hours the metal of the heat exchanger was bright and clean, absolutely free of its heavy deposit of scale.

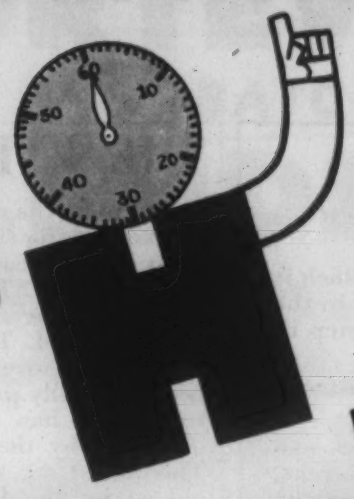
Pennsalt PM-90 is an acid-type chemical cleaner. It can be used warm or cold, concentrated or diluted to remove rust, corrosion and scale deposits. Can be used safely on iron, steel, copper, brass, bronze, nickel, and their principal alloys.

The Pennsalt Man is trained to help you produce better cleaned products at a faster rate and at lower cost. If you would like to see him, write to Dept. MM-6. If your problem is urgent—wire, and he will call immediately.

PENNSALT
96 YEARS OF SERVICE TO INDUSTRY
PENNSYLVANIA SALT MANUFACTURING COMPANY
Chemicals
Special Chemicals Division
1000 WIDENER BUILDING, PHILADELPHIA 7, PA.
NEW YORK • CHICAGO • ST. LOUIS • PITTSBURGH
CINCINNATI • MINNEAPOLIS • WYANDOTTE • TACOMA

DON'T PASS THIS UP!

IMPORTANT 60-SECOND STORY OF



HOFFMAN FILTRATION BENEFITS . . .

★ PRODUCTION BENEFITS

Coolant control by Hoffman Filtration increases production, enhances precision finish and reduces rejects.

★ IMPORTANT SAVINGS

Clean coolant lengthens life of machines, cutting tools and grinding wheels; also reduces maintenance, as machines operate longer cycles without cleaning.

★ EXCLUSIVE FEATURES

Hoffman offers the flotation process for soluble oil and filter-aid and non-filter-aid equipment for all types of coolants and vacuum stills.

★ COOLANT TEMPERATURE CONTROL

Some Hoffman models are self-cleaning and offer automatic sludge removal features. Hoffman refrigeration units aid in maintaining tolerances.

★ ENGINEERING SERVICE

Experts are available to help you determine sizes, flow rates, capacities, filtering area required, etc. We offer a filtration planning and layout service.

★ SEND FOR LITERATURE

U. S. HOFFMAN MACHINERY CORPORATION
223 Lamson St., Syracuse, N. Y.
COOLANT FILTERS • FILTRATION ENGINEERING SERVICE

Resin Binder for Core Sand

A newly developed synthetic resin binder that improves the core sand used in casting such metals as aluminum and magnesium is announced by *Resinous Products & Chemical Co.*, Philadelphia, Pa. Known as "Uformite 580," this binder is a urea-formaldehyde resin, and is a dust-free, water dispersible powder. It may be added directly to the conventional muller, kneader or paddle-type mixers and uniformly dispersed throughout the sand without special precaution.

Since this resin decomposes at the pouring temperatures of aluminum and magnesium much more rapidly than do drying oils, cores bonded with it break down readily during contraction of the metal on cooling and solidification, thereby overcoming the possibility of "hot tears" or metal strains as well as facilitating removal of the core through narrow constricted openings during casting clean-up.

Its use in sand mixes relieves any tendency to stick to core boxes, conveyors and blower equipment. Core boxes may be used continuously without delaying production to clean interiors. Core sands mixed with this resin may be stored prior to baking as long as 4 to 5 hr. without loss in tensile strength or surface hardness.

● A new stripper for removal of many types of organic coatings is announced by *Enthone Co.*, Dept. MA, 442 Elm St., New Haven, Conn. Synthetic enamels such as alkyds, melamine and urea formaldehyde coatings are readily stripped by this "S-300." It can be used full strength at room temperature or may be diluted with water and heated to 150 to 180 F. Enamels are removed by a wrinkling action, leaving the work clean and bright. Active metals, phosphate and anodized coatings are unharmed.

Instrument for Detecting Impurities in Gases

Both oxygen and hydrogen impurities in gases may be detected and measured by the same instrument designed and constructed by *Baker & Co., Inc.*, New York. The instrument was first developed for determining oxygen impurities but has been further refined for testing and measuring the presence of hydrogen gases.

The instrument is suited both for industrial and laboratory use. It indicates the presence of from 0.001 to 1.0% oxygen impurities. In industry the indicator will find many uses. For example, it can be used to detect traces of oxygen in sintering atmospheres; it can also help to avoid spoilage by detecting and measuring any oxygen impurity in the gases used for filling tubes and lamps.

Minute quantities of oxygen in the atmosphere of heat treating and brazing furnaces may also be detected and measured.

SALEM ENGINEERING COMPANY

Since 1935

Salem "Engineered Heat" has solved many outstanding problems in heat treating aluminum sheets, bars and tubes including car type furnace operations and the largest rotary forge furnace in the world.

Salem has used Spencer Turbos constantly since 1935.

In one compact unit, the Spencer Turbo combines simplicity with unusual reliability, and provides a steady flow of clean air with a constant pressure.

Power varies with the load and efficiencies are high at all loads, resulting in extremely high over all efficiencies under fluctuating service demands.

Maintenance records show that batteries of Spencers operate for years at a cost of one dollar per machine per year for repair parts. Many of the Spencers built a quarter of a century ago are giving satisfactory service today maintaining their original test efficiencies.

Special Spencer Bulletins are available as follows: Data, No. 107, Gas Boosters, No. 109, Four Bearing, No. 110, Blast Gates, No. 122, Foundries, No. 112 and the General Bulletin is No. 126.

THE SPENCER TURBINE COMPANY · HARTFORD 6, CONN.

SPENCER HARTFORD **TURBO-COMPRESSORS**

280-T

YOU NAME IT

. . . we'll make it

DURALOY

What kind of a casting do you need? What corrosive condition must it meet? What temperature? Any abrasion? How much tensile strength must it have?

If you need a chrome-iron, chrome-nickel or nickel-chrome casting, keep these facts in mind:

1 . . . Duraloy is a pioneering company in the field of static high alloy castings, specializing in these since 1922.

2 . . . Duraloy also pioneered in the field of centrifugal castings, starting this phase of its business in 1931.

3 . . . Duraloy has one of the most modern and best equipped high alloy foundries in the country.

4 . . . Duraloy is staffed to start in with the problem and take care of all necessary steps to produce the casting, finished as you require.

Make Duraloy your source of supply for high alloy castings.

THE DURALOY COMPANY

Office and Plant: Scottdale, Pa. • *Eastern Office:* 12 East 41st Street, New York 17, N. Y.

Los Angeles & San Francisco
KILSBY & HARMON

Chicago & Detroit:
F. B. CORNELL & ASSOCIATES

METAL GOODS CORP: St. Louis • Houston • Dallas • Tulsa • New Orleans • Kansas City

6-DU-1

Motor Driven Power Wrench

A motor-driven power wrench designed to reduce chucking time and eliminate the worker fatigue of heavy "wrench wrestling" is announced by the *Fen Machine Co.*, Cleveland. The wrench consists of an electric motor driving a wrench head adapted to the particular chuck being used.

The wrench head is introduced into the socket, rotated and withdrawn by means of a simple hand control. This control is placed conveniently at the operator's left hand, allowing the right hand free at all times for handling the work piece. The wrench does not need to be "set" for any specific operation. It is not restricted in action but will move the chuck jaws to the full extent of their travel.

Tension of the chuck jaws is always at the control of the operator; a simple touch of the control lever regulates tension on the work, allowing a light grip for thin walled pieces to prevent distortion and a heavy grip to hold the heavier work. This ease of operation is especially valuable in chucking and working irregularly shaped pieces.

The wrench is mounted at the back of the machine and does not interfere in any way with the operator's natural freedom of action. The wrench is readily adapted to any type or size of machine and to any chucking, gripping or clamping operation. It is also useful in heavy bolt tightening and similar operations.

● A new portable pyrometer, with a direct reading scale, is now available from *Roller-Smith Co.*, Bethlehem, Pa. It can measure furnace temperatures, molten metals, chemical baths, lead and zinc pots and other temperature readings in the 1200 F range. It is simply inserted into the liquid or atmosphere and read from the scale. It is built to withstand normal strains of jars, vibrations, etc.

Barrel Plater

Lasalco, Inc., St. Louis, has introduced a new intermediate barrel plater to fill the need for a plater between the capacities of their small utility and regular size barrel platers.

Several interesting, time saving features are incorporated in this plater. Loading and unloading is done by a counterbalancing arrangement which automatically places the cylinder in correct position and is held there by a handle and ratchet device. Loading trays are unnecessary.

Other advantages are a switch type negative contact which is made automatically when cylinder is loaded into tank and an insulated negative connection through hollow hub of cylinder which prevents interference while loading or unloading.

The barrel plater is arranged for 3 speeds, has a ⅛-hp. motor, a 10-in. by 18-in. hard rubber cylinder with 8-qt. or 30-lb. capacity, and is furnished with steel tank for cyanide solutions or rubber-lined tank for nickel solutions.

PHOTO COURTESY OF THE BETTMAN ARCHIVE

FROM A METAL MAKER'S "FAMILY ALBUM"

WHEN HAMMERS WORKED LIKE THIS—

Standard's Present Plant Had a Double-Acting "Ten-Tonner"

This scene shows advanced hammer-forging practice in 1867 . . . and the plant of Standard Steel was never one to lag behind. A modern, double-acting, ten-ton steam hammer with wrought iron frame, purchased in England, was installed in a new stone building. This building is still standing . . . and descendents of some of the men who worked that new hammer are valued employes at Standard today.

Like the oak from the acorn, great things have grown from this beginning. Now Standard's forge shop has fourteen hammers, with capacities from 3500 to 12,000 pounds, and six steam hydraulic presses with from 600 to 2500 tons capacity. Locomotive or marine forgings, shafts, rolls, ordinance forgings or any forging of a weight not exceeding 25 tons which can be made under press or hammer, can be efficiently produced.

When you need forgings or castings, you can simplify the job of getting them very easily. Just "Standardize on Standard."

BLW THE BALDWIN GROUP **BALDWIN**

FORGINGS AND CASTINGS

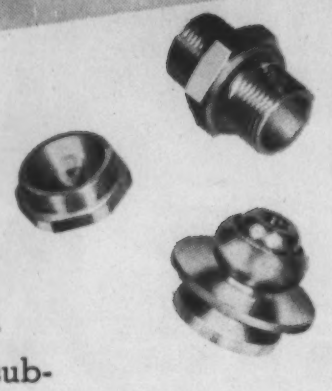
The Baldwin Locomotive Works, Standard Steel Works Division, Burnham, Pa., U.S.A. Offices: Philadelphia, New York, Chicago, St. Louis, Washington, Boston, San Francisco, Cleveland, Detroit, Pittsburgh, Houston, Birmingham, Norfolk.

"STANDARDIZE ON STANDARD" FOR YOUR FORGINGS AND CASTINGS

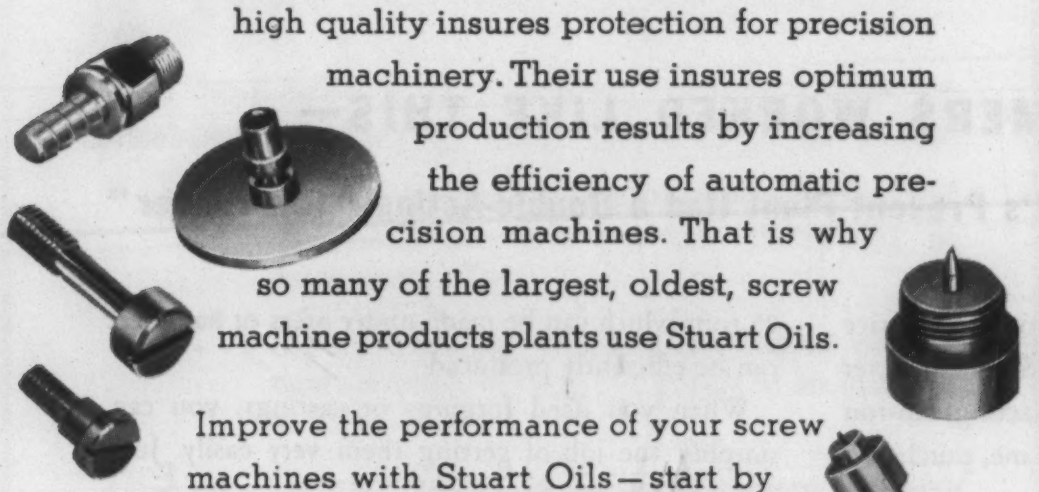
AUTOMATIC SCREW MACHINES

Perform Best with Stuart's

ThredKut ThredKut 99 SPEEDKUT SUPERKOOL Base



STUART engineers have seen it many times—the almost startling improvement in performance when one of those four Stuart products is substituted for an ordinary "getting-by" oil on a screw machine operation. The reasons for the difference are nothing mysterious. Stuart's ThredKut 99, ThredKut, SuperKool Base Blends and SpeedKut are heavy duty, high anti-weld, high lubricity oils which make improved finish and longer tool life possible—their high quality insures protection for precision machinery. Their use insures optimum production results by increasing the efficiency of automatic precision machines. That is why so many of the largest, oldest, screw machine products plants use Stuart Oils.



Improve the performance of your screw machines with Stuart Oils—start by talking it over with a Stuart sales engineer.

"Cutting Fluids for Better Machining" is a Stuart Oil handbook containing information and data on machining as well as cutting fluids. . . . Available to you upon writing—

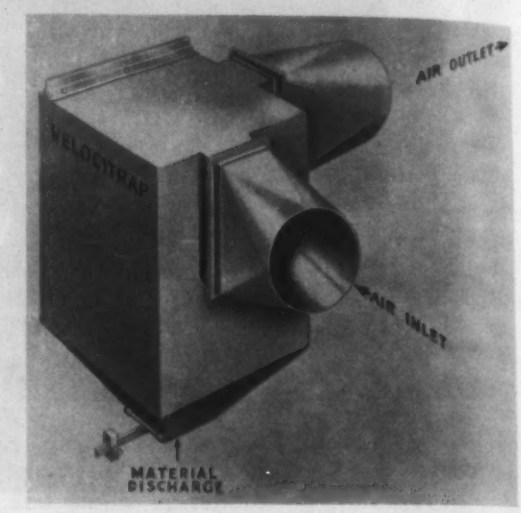
D.A. Stuart Oil CO.
EST. 1865 LIMITED
2745 SOUTH TROY STREET, CHICAGO 23, ILL.

Stuart Oil Engineering Goes With Every Barrel

Dust Collector Auxiliary Unit

Where the contaminated air removed by a dust control system contains materials that have a recovery value, or heavy or abrasive solids, an auxiliary unit developed by *Claude Schneible Co.*, Detroit 6, may be used to advantage. It salvages valuable material in a dry state for return to process, reduces abrasive wear in the duct system and collectors, and eliminates the settling out of material in the ducts.

Placed in the intake duct ahead of the collector, the "Velocitrap" separates solids from the air stream by means of a slot-shaped opening in an elbow of the duct



View of the auxiliary unit for the recovery of material from dust collecting systems.

within the unit. Solid particles are expelled by centrifugal force through the slot and deposited in a hopper.

Only a minimum of solids reach the dust collector. A smaller shielded slot, placed opposite the intake slot, re-admits the air into the duct and prevents back pressure.

In foundries the Velocitrap recovers abrasives from casting cleaning operations, and foundry sand from downdraft shake-outs, screens, mullers and sand conditioning systems. The Velocitrap is made in four types for various operating conditions, and in a range of sizes with capacities from 2,000 to 20,000 c.f.m.

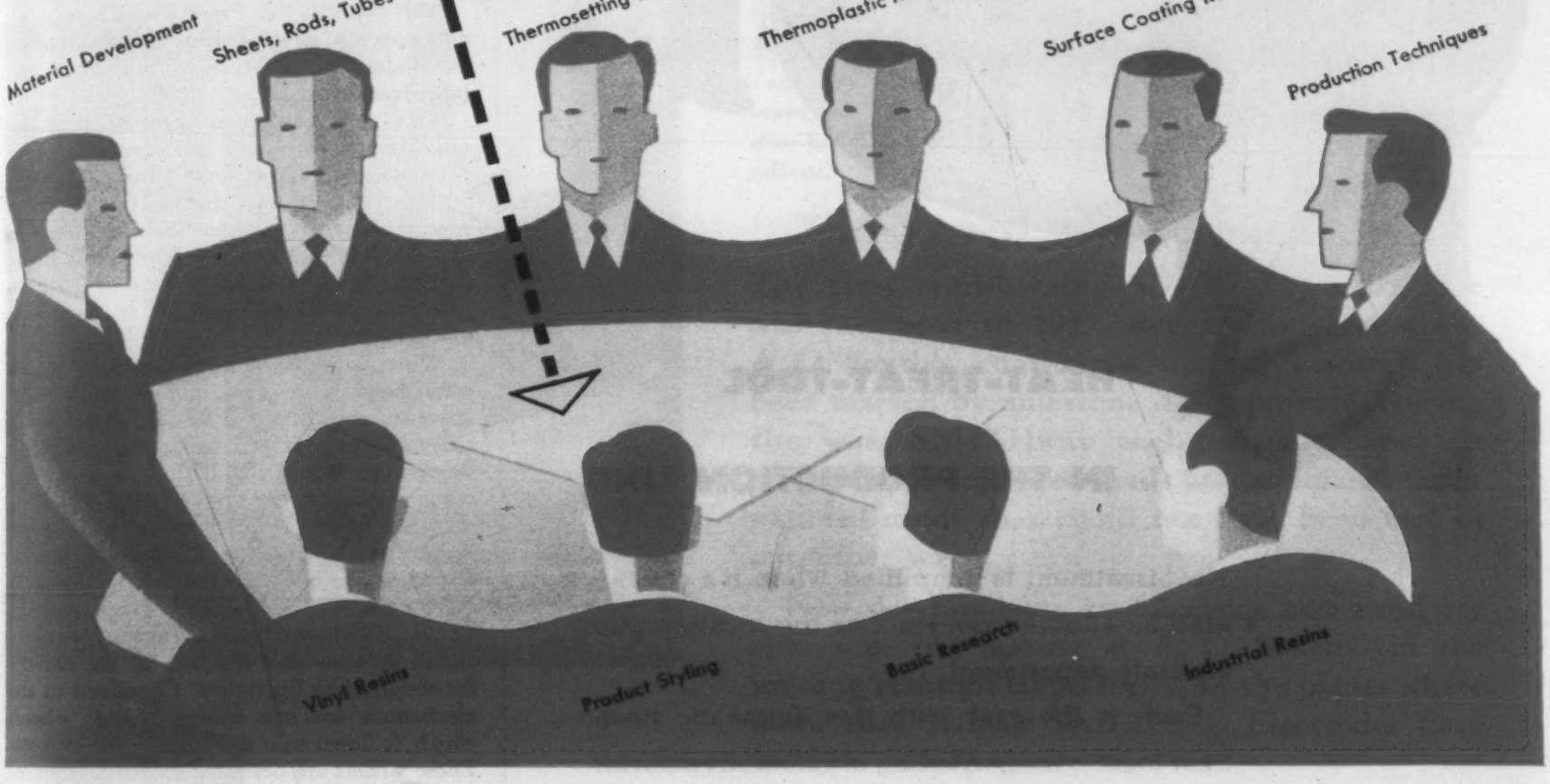
The unit is adaptable to any wet or dry-method dust collection system.

● A new high temperature furnace, to be known as the Huppert "Hi-Temp" Furnace, designed as a small capacity unit for precision treating of high-speed steel reamers, cutters, tools, etc., has been introduced by *R. H. Huppert Co.*, 6830 Cottage Grove Ave., Chicago. This furnace is recommended for continuous operating temperatures up to 2200 F, intermittent to 2250 F. Available in floor and table models, the furnace is furnished complete with automatic temperature control, and features multi-insulation, high temperature alloy elements, all-steel, heavy-duty construction, and counterbalanced door.

For a happy ending . . .

let your plastics planning

start here



You can avoid costly mistakes, second-rate results and loss of time by putting your plastics problems up to Monsanto's Plastics Technical Council *first*.

Already this group of ten picked plastics experts has given valuable help and advice to hundreds of molders, fabricators and end-users . . . authoritative, balanced counsel on materials, methods, designing, performance standards, etc.

Ten Heads Are Better Than One

This Council has been set up by Monsanto Plastics Division in answer to the needs of newcomers as well as veterans in the fast moving, ever growing plastics field. It is made up of ten experts, each one a highly qualified specialist in a different, major phase of plastics practice. Together they represent over 100 years of experience in this young industry.

How to Use the Council:

You only need to write a letter outlining your problem or your idea. The council will review your inquiry at its next regular weekly meeting. You will be sent promptly a written recommendation representing the thinking of the entire council . . . a comprehensive, practical report . . . something you can go to work with.

Unbiased Advice

With one of the broadest and most versatile groups of plastics in the industry, Monsanto's Council is under no compulsion or inclination to steer any inquiry toward one type of plastics. Also, no short-range interests are allowable; if it happens that Monsanto does not have a plastic that does the particular job in question, the inquirer is so informed.

If you have a plastics problem now . . . write to the Council for advice. To avoid delay you may wish to send in advance for our special questionnaire form. Address all inquiries: MONSANTO CHEMICAL COMPANY, Plastics Division, Springfield 2, Massachusetts.

The broad and versatile family of Monsanto Plastics includes: Lustron* polystyrenes • Cerex* heat resistant thermoplastics Vinyl acetals • Nitron* cellulose nitrates • Fibestos* cellulose acetates • Thalid* for impression molding • Resinox* phenolics • Resimene* melamines • Forms in which they are supplied include: Sheets • Rods • Tubes • Molding Compounds • Industrial Resins • Coating Compounds • Vuepak* rigid, transparent packaging materials.

*Reg. U. S. Pat. Off.

MONSANTO
PLASTICS
SERVING INDUSTRY . . . WHICH SERVES MANKIND

• more about "heat-treatment-on-the-fly"

HEAT-TREAT-TOOL

IN THE PRODUCTION LINE

Heat-treatment is simplified when it's considered as another tool—not as the location of a separate department.

Such is the case with this automatic heat-treat-tool for the hardening of automotive starter ring gears. It's right in line with forming, machining, and grinding.

Production is at a rate of 180 gears per hour. Each gear receives the same time-temperature treatment—uniformity is absolute. Work-flow is maintained—there's no extra time required for wasteful handling.

Function-fitted gas-combustion is operating on many modern production lines.

Improved Heat Processing

SELAS CORPORATION OF AMERICA PHILA 34 PA

● *Alan Wood Steel Co.*, Conshohocken, Pa., announces a new product, "Dynalloy." This new low alloy, high tensile steel will find wide use in the transportation field where it meets the requirements for light weight, low cost construction of railroad equipment, trucks and buses. Dynalloy is especially suited for use wherever corrosive action must be avoided—in the chemical industry; for smoke chambers and stacks on buildings of every type. It has the following average chemical composition: 0.12 carbon, 0.75 manganese, 0.080 phosphorus, 0.035 sulphur, 0.70 nickel, 0.07 molybdenum. Elastic limit is 50,000 lb. per sq. in.

Portable Mullor for Foundries

The *Beardsley & Piper Co.*, Chicago 39, announces a new portable mullor, known as Model No. 7 Mulbaro, for small and large foundries.

This new equipment can be used for mulling both molding and core sand. It is composed of two separate uints: the three wheeled barrow and the mulling mechanism. The barrow is used for transportation and for holding the sand while it is being mulled. It has a spring controlled, hinged bowl to facilitate ease of loading and dumping.

When sand is to be dumped, a spring mechanism is released, and a slight push moves the bowl up to a 90-deg. angle. Thus, the sand is dumped completely without shoveling. When the barrow is to be refilled with sand, the bowl is tipped back to a 45-deg. angle for quick shoveling, and the weight of the sand, as it increases, gradually forces the bowl down to a level position.

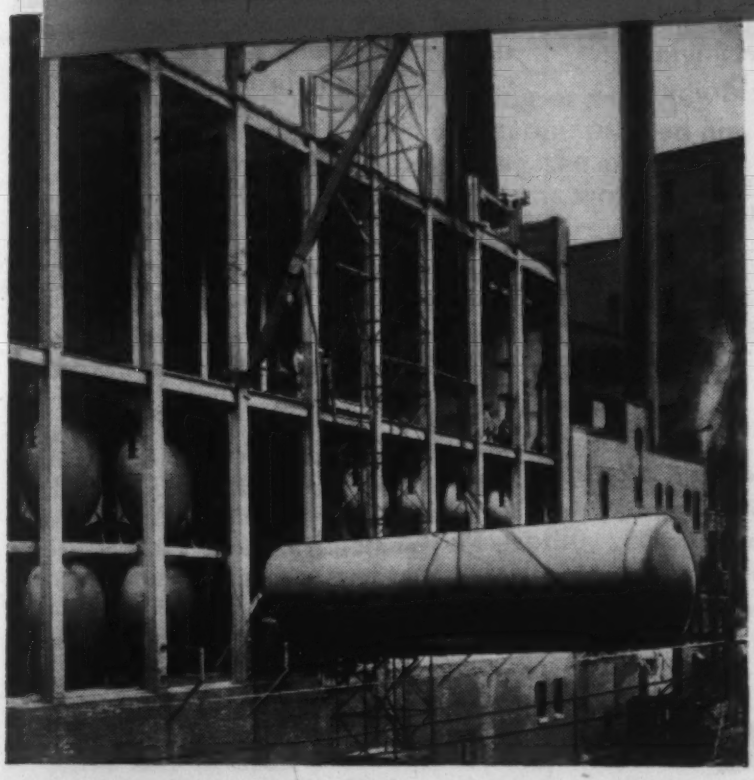
The mulling mechanism is operated by an electric motor. It is suspended by a chain, lowered and attached to the barrow for the mulling operation. Contained in the mechanism are two rubber-covered wheels which fit down into the sand in the barrow. These wheels are designed to the contour of the barrow bowl at such an angle that they accurately conform to the curve of the bowl as they travel, eliminating any tendency of sand slippage or damage to sand grain structure, all of which helps to maintain uniform permeability.

The Mulbaro's squeezing and kneading action provides proper distribution of all additions, and produces a thoroughly mulled sand.

● The *Massie Manufacturing Co.*, Minneapolis 13, has announced the development of a cleaner for sandpaper. Known as "Sand Re Nu," the liquid will dissolve the particles which have lodged between the abrasive grains and leave the sandpaper with a new cutting edge.

1933 Thousands of man-hours of welding research went into development of a SMITHway Electrode over the weld of which glass coatings could successfully be applied. The result was production of this first large single-piece glass-lined tank, shown emerging white hot from the gigantic furnace.

Out of Welding Research... BETTER BEER



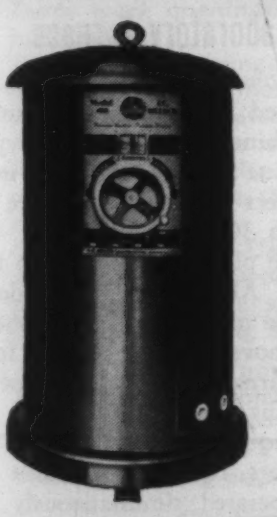
1946 Since the first SMITHway Glass-Lined Storage Tank was built in 1933, hundreds of brewers throughout the world have equipped their lagering cellars with SMITHway glass-lined tanks . . . a combined storage capacity of 39,486,188 gallons.

The Proof Is in Production

The first trail-blazing SMITHway Electrode was produced in 1917. Repeatedly since then, A. O. Smith's continuous welding research has been marked by milestone developments. During the war, SMITHway techniques, proved in peacetime production, made it possible to meet national needs that could not have been met in any other way.

New developments to fill every new need are always in the making at A. O. Smith—in the welding research laboratories, in the plants where more than 320,000 SMITHway Electrodes have been used in daily production.

Everywhere farsighted management is studying how welding—the modern production tool—improves quality, cuts cost, simplifies design, speeds production.



SMITHway A. C. WELDERS

Choose from a complete line of six models, rated at 150, 200, 250, 300, 400, and 500 amperes. Write for complete specifications and prices.

Mild Steel . . . High Tensile . . . Stainless Steel

WELDING ELECTRODES

made by welders . . . for welders

SMITHway *Certified* WELDING ELECTRODES

A. O. SMITH Corporation

NEW YORK 17 • PITTSBURGH 19 • CHICAGO 4 • TULSA 3
HOUSTON 2 • DALLAS 1 • LOS ANGELES 14 • SEATTLE 1
INTERNATIONAL DIVISION: MILWAUKEE 1 • *In Canada: JOHN INGLIS CO., LIMITED*

LOW ABSOLUTE PRESSURES

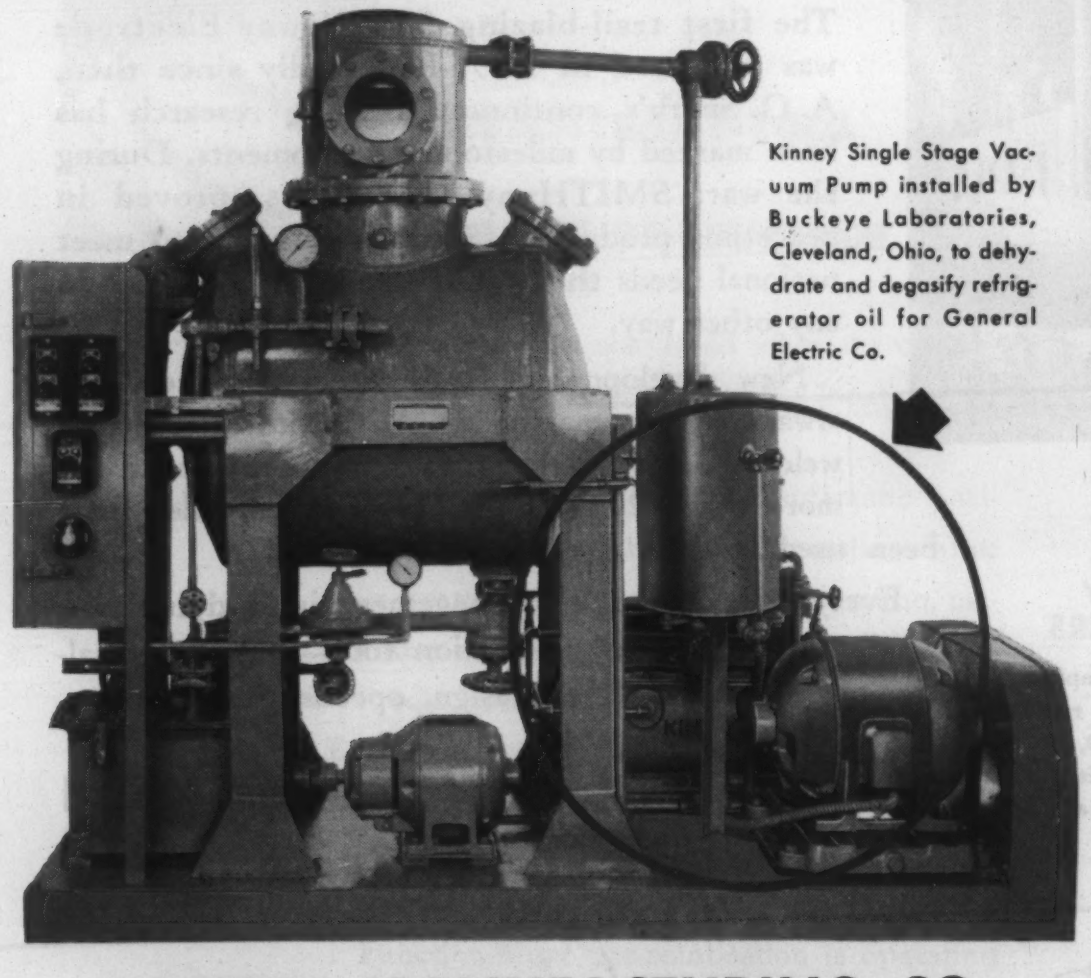
Rapidly...Continuously

KINNEY

HIGH VACUUM PUMPS

Many of the war's top secrets now out of wraps suggest the amazing possibilities of low absolute pressures in processing: Kinney Vacuum Pumps served the war program with distinction and are now being used for dependable service in countless peacetime applications. Almost without exception in the United States and in a rapidly growing number of plants abroad, Kinney High Vacuum Pumps are standard equipment for exhausting lamps and tubes. They also provide the low absolute pressures for sintering alloy metals, coating lenses, refining rare metals and producing blood plasma, penicillin and other drugs. In fact, they are used effectively wherever a dry vacuum pump can be applied, including cyclotron evacuation and atom smashing. Kinney Single Stage Vacuum Pumps produce low absolute pressures to 10 microns; Compound Vacuum Pumps to 0.5 micron.

Send for Bulletin V-45



Kinney Single Stage Vacuum Pump installed by Buckeye Laboratories, Cleveland, Ohio, to dehydrate and degasify refrigerator oil for General Electric Co.

KINNEY MANUFACTURING CO.

3523 WASHINGTON STREET, BOSTON 30, MASSACHUSETTS

NEW YORK • CHICAGO • PHILADELPHIA • LOS ANGELES • SAN FRANCISCO

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General Engineering Co. (Radcliffe) Ltd., Station Works, Bury Road, Radcliffe, Lancashire, England

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W. S. Thomas & Taylor Pty. Ltd., Johannesburg, Union of South Africa

WE ALSO MANUFACTURE LIQUID PUMPS, CLUTCHES AND BITUMINOUS DISTRIBUTORS

New Vertical Miller

A new vertical miller is being manufactured by *Kent-Owens Machine Co.*, Toledo, Ohio.

The table of this model (2-20 Vertical) is 42 in. long by 12 in. wide with a 20-in. travel, having a fully automatic cycle. It can be fed or rapid traversed in either direction, automatically shifted from rapid traverse in either direction, and automatically reversed at both ends of the stroke. It may also be automatically stopped at any desired point in its travel.

Independent adjustment can be made of the feed rate for opposite directions of table travel. This makes possible milling a part at one end of the table at a slow feed rate and also setting up a different job at the other end requiring a faster feed rate. Similarly, this independent adjustment permits setting the feed rate exactly the same for both directions of table travel.

A wide range of spindle speeds may be obtained by changing the spline mounted pick-off gears contained in the head under an aluminum cover. These gears have a wide face and run in an oil bath.

● A patented, automatic-feed, electric soldering iron is being introduced by the *Multi-Products Tool Co.*, 123 Sussex Ave., Newark, N. J. This new iron is trigger operated and ejects a measured amount of solder from a reel concealed in the handle. A special retracting feature prevents the melting of excess solder on the heating tip. The actual amount of solder deposited each time the trigger is pulled is regulated by a micrometer adjusting wheel mounted in the handle of the iron easily accessible to the operator's thumb. If, during the course of a job, more or less solder is required, a touch of the wheel changes the amount ejected.

Universal Laboratory Furnace

The *Surface Combustion Corp.*, Toledo, Ohio, has designed a universal laboratory furnace that combines three different types of furnaces into one furnace casing. It may be used as a direct fired oven furnace at temperatures from 300 to 2400 F.

A muffle can be placed on the hearth for indirect heating. Also, a diamond block can be used in the muffle if an atmosphere is desired. A removable plug is built into the arch of the furnace; it can be removed to provide a means of inserting a pot.

The furnace is equipped with three atmospheric type burners, one, two or three of which can be operated simultaneously in accordance with the temperature desired.

This furnace is designed for laboratories or small shops that require a wide variety of heat treatments of small quantities such as annealing, carburizing, hardening, cyaniding and tempering. In this unit all these operations can be done in direct fired oven, indirect heated muffle, gaseous atmosphere, salt or lead.

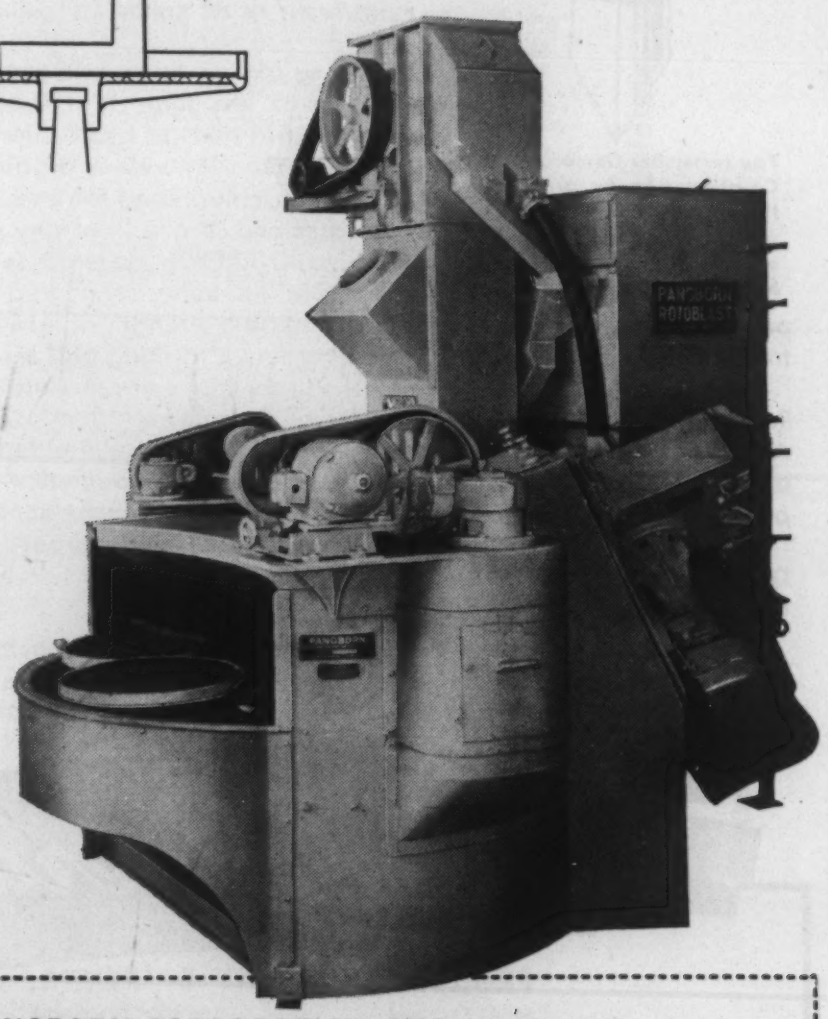
The furnace may also be used for the melting of soft and light metals.

BLAST CLEANING BOTH VERTICAL AND HORIZONTAL SURFACES *at One Time*

No other airless blast machine has this cost-saving feature

Thorough and uniform cleaning of vertical and horizontal surfaces with one pass through the machine—eliminating the necessity, in many cases, of turning the work for second and third passes . . . has revolutionized the blast cleaning of large or small castings and other metal parts on table-type machines.

Pangborn's ROTOBLAST* Table directs the blast stream onto the work at a 45° angle. Thus a great variety of shapes can be handled on this table with complete assurance that all planes will receive equal cleaning—no possibility of over-cleaning some planes.



And These Other PANGBORN FEATURES Save You More Time and Money

Variable table speed. Can be suited to the work—higher speeds (and higher production) for pieces easy to clean.
Large work openings. High work pieces easily handled.
Rim drive. Driving the table from the rim (instead of from center spindle) gives smoother motion and facilitates inspection of driving unit.
No clogging. The abrasive sweeps are rotated independently of the table; regardless of amount of abrasive thrown, the sweeps handle it without clogging.
Surface peening. Uniform abrasive impact over every point of the work table (due to 45° wheel) and variable table speed make this unit ideal for surface peening as well as blast cleaning.

Send coupon now for Bulletin 211A on ROTOBLAST Tables. And for any type of blast cleaning equipment—airless or compressed air—"Come to Pangborn", *world's largest manufacturer of blast cleaning and dust control equipment.*

*Trademark of the Pangborn Corporation

Pangborn

PANGBORN CORPORATION, HAGERSTOWN, MARYLAND

PANGBORN CORPORATION, 299A Pangborn Blvd., Hagerstown, Maryland

Gentlemen: Please send me free Bulletin 211A on ROTOBLAST Tables.
Check also for information on: ROTOBLAST Rocker Barrels ☐ ROTOBLAST Special Machines ☐ Air Blast Rooms ☐

Name.....

Company.....

Address.....

does this

"SWORD OF DAMOCLES"

menace your floors?

You remember Damocles the Courtier, who by order of the tyrant Dionysius, was seated at a banquet with a sword suspended over his head by a single hair.

THIS FLOOR WILL THRIVE ON ACIDS, ALKALIS, AND OTHER PUNISHING ELEMENTS LISTED AT LEFT... AND WILL TAKE THE HARDEST KIND OF MECHANICAL PUNISHMENT IN ITS STRIDE...

Atlastic No. 31 Plastic Membrane is first applied to concrete sub base and floor is constructed of Atlas Acid-proof Brick, joined with ALKOR resin cement.

ALKOR, one of five Atlas Acid-proof cements, has an absorption of less than 1%. It sets to an infusible cement which is inert to hydrochloric, sulphuric, phosphoric, hydrofluoric—various organic acids, hydrocarbons, Toluene, chlorinated solvents, keytones, alcohols, oils, greases and to alkalis of any concentration.

Atlas ACID-PROOF textured-surface BRICK, used with ALKOR, has adhesion of approximately 600 lbs. per sq. inch. Combined with the remarkable strength of ALKOR, this withstands tremendous mechanical shock, as from heavy trucking and severe impact.

Such floors as this—thousands of square feet—are serving in Chemical plants, Rayon plants, Steel mills, Plating rooms, Petroleum refineries, etc. Because these ATLAS Floors are not only proof against all the solutions listed, but in addition are impervious and sanitary, *they are being used in new streptomycin and penicillin plants* where all these properties are of utmost importance.

ATLAS OFFERS A COMPLETE SERVICE – Acid-proof Materials, Proven Design and Methods of Construction. If desired, construction may be done under our supervision.

When you need construction or replacement of acid-resisting units, contact an Atlas representative at our nearest branch office. Write our Mertztown office for Technical Bulletin TV-9A.

THE *Atlas Mineral*

PRODUCTS COMPANY OF PENNA.

MERTZTOWN PENNSYLVANIA

***ATLANTA 3, Ga., 161 Spring St., N. W.**

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***DETROIT 2, Mich., 2970 W. Grand Blvd.** — **SPRINGFIELD, Pa., 355 Fairview Rd.**

***KANSAS CITY 2, Kan., 1913 Tauromee Ave.** — **ST. LOUIS 8, Mo., 4485 Olive St.**

THE ATLAS MINERAL PRODUCTS COMPANY OF CALIFORNIA, Redwood City, California

***DENVER 2, Colo., 1921 Blake St.** — ***SEATTLE 4, Wash., Rensselaer Valve Co., 1252 First Avenue, S.**

***HONOLULU 2, Hawaii, U. S. A.**

***LOS ANGELES 12, Calif., 172 So. Central Ave.** **Stocks carried at these points.*

IN CANADA: Atlas Products are manufactured by

H. L. BLACHFORD, LTD., 977 Aqueduct Street, Montreal 3, 86 Bloor Street West, Toronto 5

Grinding Wheel Dresser

A grinding wheel dresser, with forced-feed lubrication, has been developed by *G. J. Wallen Manufacturing Co.*, San Francisco 7. Grit cannot get into this tool, according to the manufacturer, because bearings and cutters are completely sealed in pressure-fed grease. The pressure of the grease prevents grit from feeding back into the dresser. Grit, therefore, has no chance to destroy the bearings and shaft hole in the cutting star before the teeth are used up.

Accuracy is maintained throughout the life of the tool, as bosses on each side prevent any side play. Thus, the operator can "peel" or start at one side of the wheel and work toward the other side, cutting under any soft metal such as aluminum or lead with which the wheel may have become "loaded".

This grinding wheel dresser has forced-feed lubrication.

Grease that accumulates within the head of the dresser catches the dust or fine grit, which is always present when dressing or truing wheels, and prevents it from being inhaled by the operator. Grease does not accumulate on the grinding wheel but is thrown off by centrifugal force.

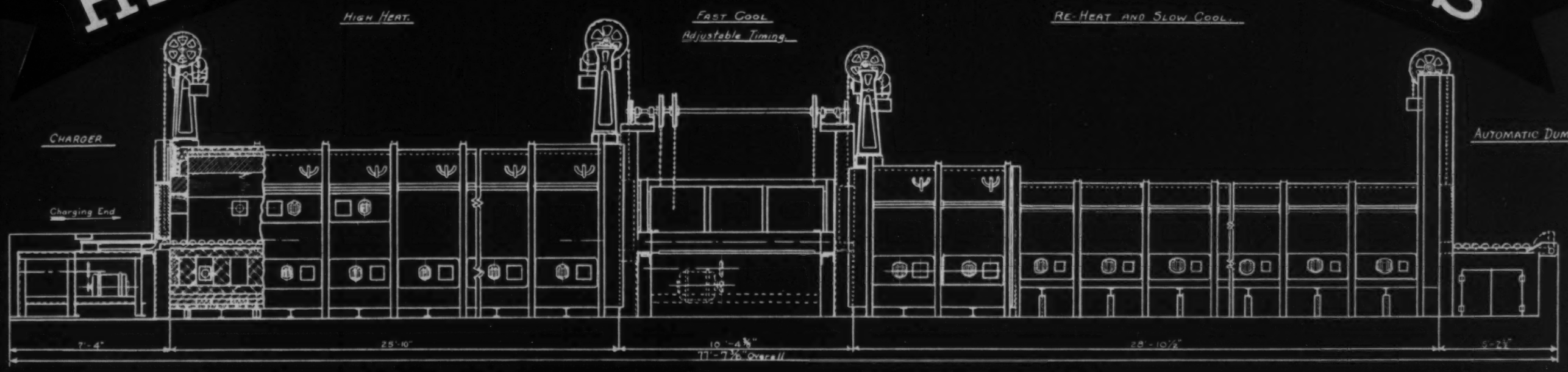
● A new improved bench type spot welder is announced by *Weldex, Inc.*, Detroit 10, Mich. This new machine is a 3 Kva, 220-volt, 60-cycle, single phase, air operated, electronically timed, precision welder. This welder, known as "Weldex Model 263-A," is being recommended for spot welding of light weight metals up to 18-gage C.R.S. or equivalent.

Corrosion Resistant Finish

A chemical treatment that produces a chromate film on zinc or cadmium plated parts to give a bright, transparent finish has been added to the line of finishes manufactured by *Rheem Research Products, Inc.*, Baltimore.

The finish is corrosion resistant. The parts to be treated are immersed in the solution for 5 sec., followed by the usual rinsing and drying. A low-concentration caustic rinse is sometimes used following the rinse to yield a more brilliant finish.

HAGAN ANNEALING FURNACES



This Hagan 78-foot Pusher Type Annealing Furnace was designed and engineered for faster, continuous annealing of automotive parts . . . completely automatic from charging end to dump . . . adjustable timing for fast and slow cooling. Another example of Hagan ability to build efficient industrial furnaces to do your heating job better and more economically.

GEORGE J. HAGAN COMPANY PITTSBURGH, PENNA.
DETROIT CHICAGO LOS ANGELES SAN FRANCISCO

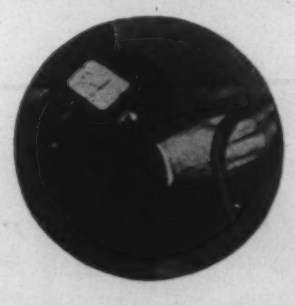
CHECK
BLOWERS
AND EXHAUST
SYSTEMS
Instantly
with the Alnor Velometer

This instantaneous direct reading air velocity meter measures air speed in feet per minute. There are no calculations, no timing, no conversion tables; its use is so simple that anyone can take accurate measurements with the Velometer. Extension jets permit correct readings in many locations that would be difficult or impossible to reach with other means of measurement.

Keep exhaust equipment working efficiently by regular checks for draft, leaks, blower operations, etc., with the Alnor Velometer. You can get accurate information on performance with a few minutes' inspection at regular intervals.

The Velometer is made in several standard ranges from 20 fpm to 6000 fpm and up to 3 inches static or total pressure. Special ranges available as low as 10 fpm and up to 25000 fpm velocity and 20 inches pressure. Write for Velometer bulletins.

Velometer used for positive static pressure readings



ILLINOIS TESTING LABORATORIES, INC.
420 North La Salle Street
Chicago 10, Illinois

Ductility Testing Machines

Two new ductility testing machines—one with a 15,000-lb. capacity for stock up to ⅛-in. in thickness and one with a 30,000-lb. capacity for stock up to ¼-in. thickness—are announced by *Steel City Testing Laboratory*, Detroit 4.

The permanent head is piloted to the main cylinder body. This provides for, the upper grip held in the head and the one mounted on the piston, being always completely concentric and for the penetrator starting the cupping at the exact center of the opening in the grip.

Another advantage of the multiple piston construction is that the specimen is automatically held between the grips with a load in proper proportion to the one being applied in forming the cup, and important improvement over the older models where the specimen was clamped manually.

Operation of these testing machines consists of placing the specimen in the opening between the grips and the closing of the control valve; the load is applied automatically and uniformly to grip the specimen, followed immediately by the penetrator forming the cup. Then by reversing the control valve the pressure is released and all functioning parts return to their original position and the specimen is easily removed.

Cupping tools and dies are supplied for easy removal of grips and penetrator.

● A new, fast, noninflammable paint remover has been made available to the metal industries by *Kelite Products, Inc.*, of Los Angeles, makers of industrial cleaning compounds. This new material is safe on any metal or hardwood surface and provides the speedy removal of all types of paint and enamel. Preparatory tests, as well as recent reports, have indicated that as many as eight coats of paint can be penetrated, loosened and removed in one step, taking no longer than 30 min. Complete removal of one or two coats can be accomplished in 10 min. Removal after penetration is easy in that paint or enamel can be sheeted off by a pressure rinse.

Magnesium Developments

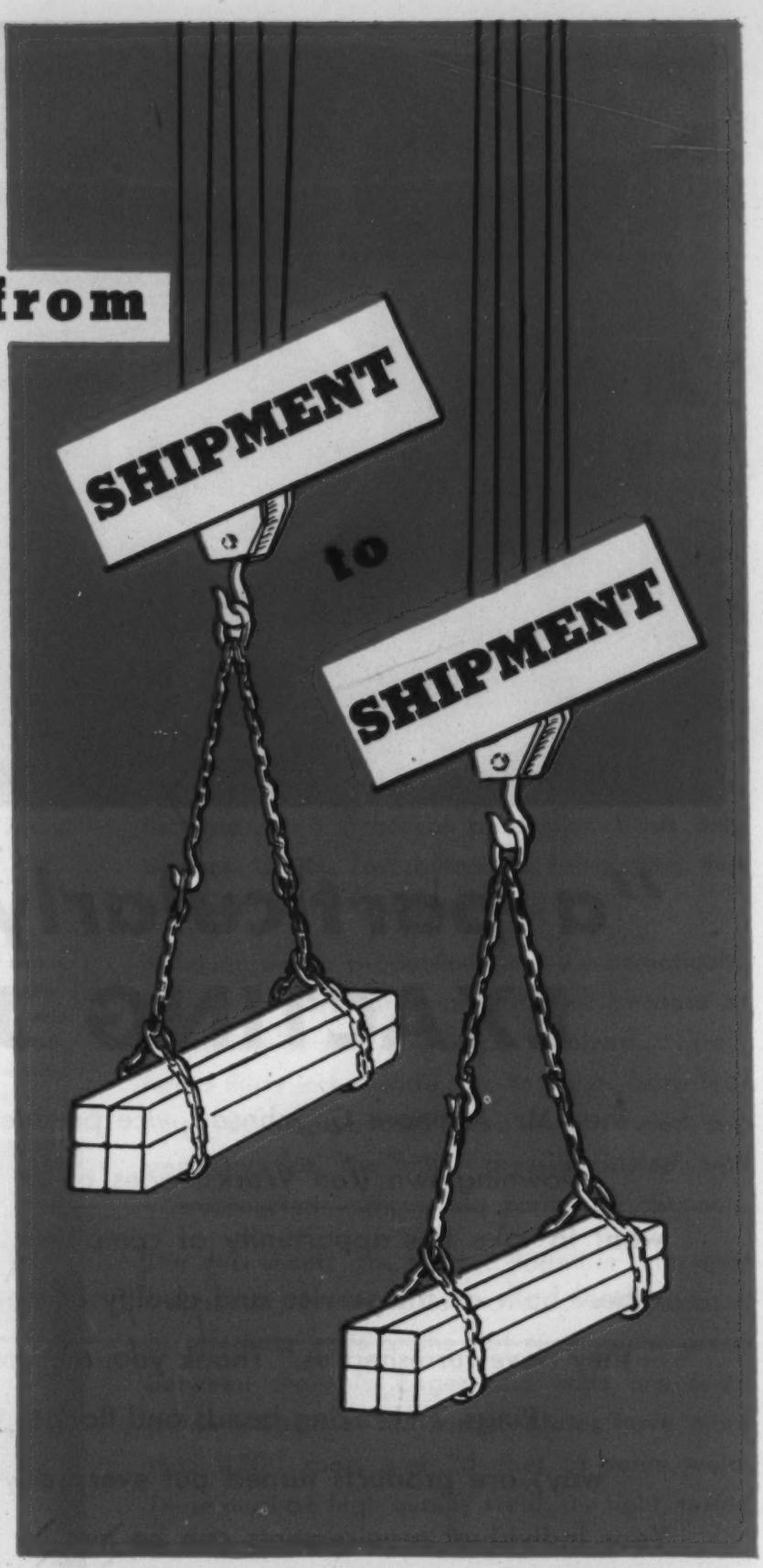
Keeping step with swiftly-moving trends in the use of magnesium metal, the *Bureau of Mines* has conducted a number of investigations concerned with this light weight metal.

A less expensive method of producing high-grade magnesia—one step in the metallurgy of making metallic magnesium—from the magnesite ores of the Pacific Northwest has been developed in the Bureau of Mines Laboratories. Known as the bicarbonate leaching process for the production of magnesium oxide, it is an adaptation and refinement of a process studied for nearly a century but never actually developed to the point reached by the Bureau.

The work was done in cooperation with the State College of Washington, and was aimed at the utilization of the largest deposits of low-grade magnesite in Stevens

(Continued on page 1706)

Uniform Forging Characteristics from



If any one reason for preferring Timken Alloy Forging Steels stands out in the minds of our customers more than any other, it is *uniformity from one lot to the next.*

This means consistently good behavior in forging, fewer delays, fewer rejects and better quality in the finished product.

The uniformity of Timken Alloy Steels comes from special practices, many of which are practical only in a large flexible specialty mill.

It comes from the particular skill which metallurgists and workmen develop through years of concentration on alloy steels exclusively.

It comes from the most precise control methods known to steel making.

And it comes from leadership in research which has paced the new developments of the industry for many years.

A member of our Technical Staff will be glad to give you the benefit of our experience in recommending an analysis for your particular application. Our 72 page book, "Evaluating the Forgeability of Steels" may prove helpful. Write Steel and Tube Division, The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
Fine Alloy
STEEL AND SEAMLESS TUBES

★YEARS AHEAD — THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS in hot rolled and cold finished Alloy Steel Bars for forging and machining applications as well as a complete range of Stainless, Graphitic and Standard Tool Steel analyses; *also* Alloy and Stainless Seamless Steel Tubing for mechanical and pressure tube applications.

"a particularly EXACTING JOB"

then Mr. Ashmore C. Johnson, vice president of Downingtown Iron Works, goes on to say: "We want to take this opportunity of complimenting King Fifth Wheel both on the service and quality of work which they have furnished us." Thank you, Mr. Johnson.

Rings, embracing bands and flanges (bent the hard way) are products turned out every day at this plant. Your individual requirements can be met by King if it's bending you want. Small, medium, large rings bent to exacting tolerances . . . that's King's job. You are invited to send for the latest folder.

Our thanks again to Mr. Johnson and Downingtown Iron Works for the photo topping the ad.

KING Fifth Wheel COMPANY

2925 N. Second Street, Philadelphia 33, Pa.

County, Wash. Magnesite is one of the several abundant American minerals from which metallic magnesium can be produced.

After the successful operation of a semi-pilot plant to produce the high-grade magnesia in the Bureau's laboratories, the metallurgists reported that the process appeared to be a feasible and relatively inexpensive method for production of high-grade magnesium oxide as a continuous operation in units of large capacity.

When magnesite is used as a raw material for producing magnesia and then metallic magnesium, impurities such as dolomite, calcite, olivine, serpentine and silica must be removed from the crude ore either before or during the reduction process. Flotation and other ore-dressing methods will separate a large part of the impurities from a low-grade ore, but more expensive chemical methods must be used to obtain a technically pure magnesium oxide or salt. It was toward this end that the Bureau's metallurgical work was directed.

The Bureau of Mines has also investigated the utilization of foundry wastes and developed efficient methods for recovering large percentages of magnesium from fine dusts and from the skimmings and leavings of smelting and refining pots.

Heavy demands for magnesium metal during the war, together with the fact that a great deal of the metal was lost in processing, prompted the Bureau to work on metallurgical processes for adding scrap-pile magnesium to the limited volume of ingots being produced. In wartime plants where magnesium was used in airplanes and in the manufacture of incendiaries and pyrotechnics, producers and foundrymen reported that scrap or wasted material amounted in some instances to about 35% of the weight of the finished products.

Regarding finer dusts, the Bureau recommends that magnesium grindings be destroyed instead of processed because of the ignition hazards and the high costs that are involved. Non-metallics removed during the treatment of magnesium dross, the article states, possibly can be utilized in fertilizers for their potash and magnesia content.

● The *Ellanar Chemical Co.*, Chicago 6, has developed a new cold wire stripper for use on magnetic wire covered with plastic coatings and enamel. It can be used in place of the cruder methods using wire brushes, knives, and abrasive cloth.

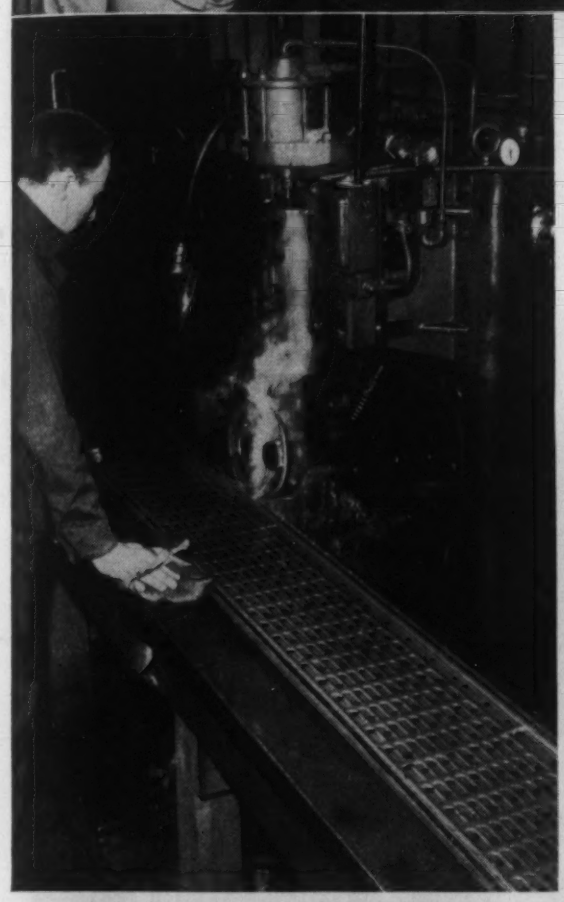
New Metal Marker

A new marking device for marking any surface such as wood, paper, glass, metal, and plastic, wet or dry surfaces, hot surfaces up to 450 F or cold surfaces to —40 F is being marketed by *Cushman & Denison Mfg. Co.*, New York 11.

The new marker is known as the Fountainbrush. It is of light construction, made to be carried in the pocket, and can use a variety of marking colors which are waterproof and permanent.

There is an automatic control valve that feeds the marking color by slight pressure; this eliminates sweating, leaking and flooding.

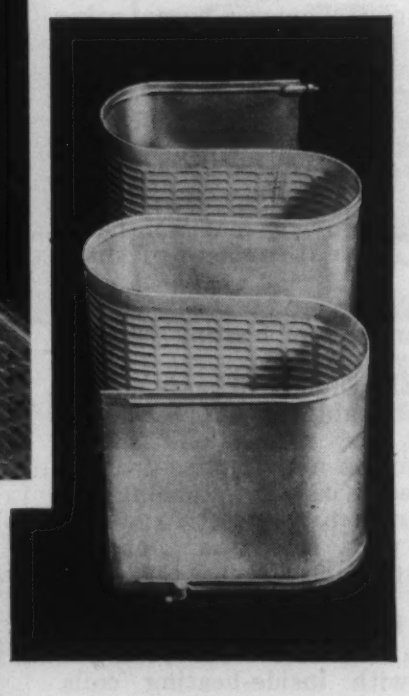
Resistance Welding "by the Mile" Makes Products Like This Possible

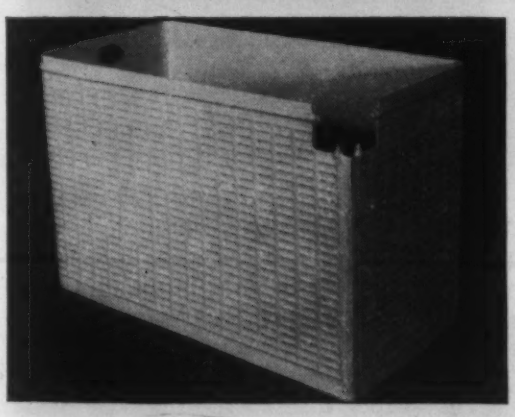


ABOVE . . . A long roller table through the throat of the Federal welder makes indexing the plates an easy matter. This plate takes 1600 spots.

•

AT LEFT . . . A similar roller table is used with the Federal seam welder. About twenty-two feet of weld around this plate. When Infra-Red-Baked finish is applied to the plates the welds are not discernible.





The serpentine shaped plate above makes an efficient refrigerating unit for a four-can ice cream cabinet. Square one at left is for a deep-freeze unit. Note the bending these welded fabrications must stand and still be gas-tight.

Seven Federal 75 KVA press type spot welders and two Federal 150 KVA seam welders deliver close to a million spot welds and some five miles of seam weld weekly to produce thousands of feet of Hubbell-Yoder Refrigeration Plate, at the Cleveland plant of The Yoder Company Fabricating Division.

These patented plates make deep-freeze cabinets, refrigerator cars and trucks, ice cream cabinets and frozen food lockers easier to produce, cheaper and more efficient. They are typical of the many useful products which can be manufactured on a practical production basis only because of the fast automatic fabrication that is natural to resisiance welding.

Although similar production can be automatically fed, these plates are hand indexed because of the variety of sizes and shapes involved . . . from ten to thirty inches wide, two to ten or more feet long. Two sheets of cold rolled steel are used, one perfectly flat, the other press-embossed with interconnected vertical and horizontal channels.

The two sheets are welded together with spot welds, using three-quarter inch electrodes, located at alternate ends of the flat rectangular areas between channels. Edges and ends are seam welded. Some of the larger plates have more than 2200 spots and 25 feet of seam weld. These must be high quality weld, air tight, tested to 200 pounds pressure.

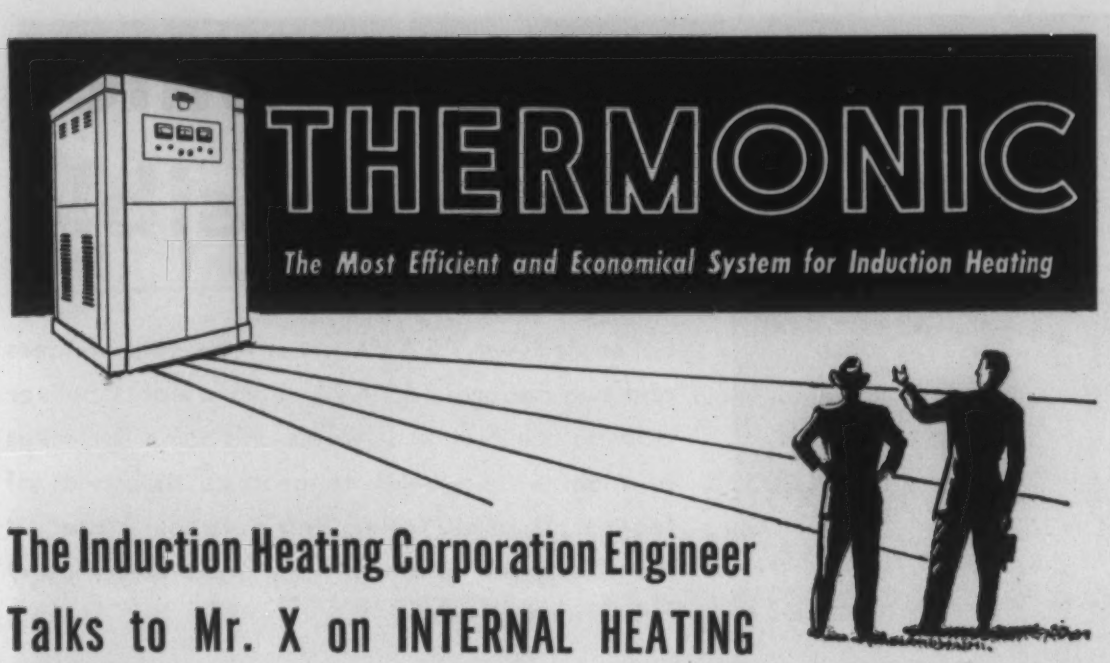
The Standard Federal welders and equipment used in this production, can be used for an endless variety of ordinary or unusual fabrication. It is worth while to remember that resistance welding may well be the answer in <u>your</u> production . . . that Federal engineers are available to help you find out . . . that in resistance welding the name of authority is

THE Federal MACHINE AND WELDER CO.

SUBSIDIARIES
Sammer and Adams Co., Cleveland—SPECIAL HIGH PRECISION MACHINES
The Warren City Mfg. Co., Warren—WARCO PRESSES and PRESS BRAKES

Federal

MEMBER RWMA RESISTANCE WELDER MANUFACTURERS ASSOCIATION



The Induction Heating Corporation Engineer Talks to Mr. X on INTERNAL HEATING

MR. X: I can see now, Mr. Engineer, how progressive heating enables your THER-MONIC Induction Heating units to heat-treat large as well as small parts. I've noticed, however, that in all your demonstrations the part has been inside the coil. Does this mean that your equipment hardens only outside surfaces?

ENGINEER: No, Mr. X. While it's true that the applications you've seen involved hardening of external surfaces, don't get the idea that internal surfaces can't be handled by this equipment. As a matter of fact, THER-MONIC units have surface-hardened the inside diameter of hundreds of hollow parts, such as internal splines, wheel hubs, thread-ring gauges, cylinders, cylinder liners, gun bores, and dies.

MR. X: Just how do you go about induction-heating internal surfaces?

ENGINEER: That's quite simple, Mr. X. In most internal-heating operations, a heating coil of one or more turns is placed inside the hollow area. The start button is then pushed to energize the equipment. This causes the internal surface to be heated and subsequently quenched automatically. The only differences between this and outer-surface heating are the location of the coil inside the part and the somewhat slower heat transfer in this case.

MR. X: I follow you. But I wonder why internal surfaces involve a slower heat transfer than external surfaces.

ENGINEER: That's because the density of a magnetic field is obviously less outside than inside a coil. The magnetic field produced by internal-heating coils is thus somewhat diminished at a given distance from the coil's surface. To compensate for this loss of available energy, we increase the density of the magnetic field, by increasing the current flowing in the coil, or by bringing the current-carrying coil closer to the surface to be heated.

MR. X: Do you ever use progressive heating on internal surfaces?

ENGINEER: Yes, Mr. X. Where, due to the amount of area involved, the use of a "single-shot" type of operation would result in insufficient power per unit of surface area, we lower the internal surface gradually or progressively over the coil so that only a narrow band is heated and quenched at a time.

MR. X: What kind of internal surfaces have you heated by induction?

ENGINEER: Probably the most prominent application we've had is the internal hardening of cylindrical surfaces for wear resistance. This operation lends itself to all types of cylinders in which pistons are to function, such as internal-combustion engines, pumps, and similar devices. We have hardened the internal surfaces of small-diameter bores, using narrow, single-turn loops, known as "hairpin coils." The smallness of the bore's diameter makes it impractical to wind coils for this purpose. But by using hairpin-type coils and rotating the work, we have heated inside diameters as small as 3/8". This application is particularly useful in hardening the internal surfaces of small dies.

MR. X: What would you say are the main advantages of heating internal surfaces by induction?

ENGINEER: One of the main advantages is the ability to produce intense heat very rapidly and confine this heat to the inner surface, where it is needed, without disturbing the metallurgical characteristics of the rest of the part. In addition, not only circular internal surfaces, but cavities of all shapes can be effectively heated by having the coil match the particular cross-section. Results achieved with inside-heating coils show that distortion is minimized due to the low ratio of heated to unheated metal. This immediately marks the THER-MONIC Induction Heating unit as a tool for heat-treating parts which often present obstacles in flame, furnace, and other methods of heat treatment.

THERMONIC
INDUCTION HEATING CORP. NEW YORK

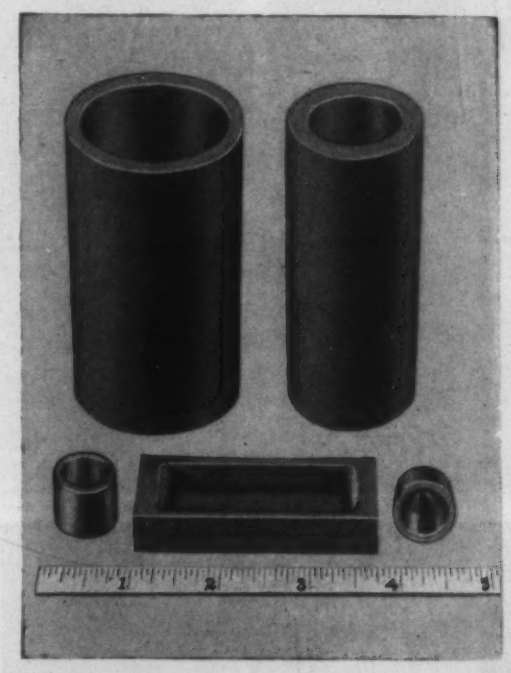
INDUCTION HEATING CORPORATION
389 LAFAYETTE ST. · NEW YORK 3, N. Y.
Largest Producers of Electronic Heat Treating Equipment for Forging
Brazing · Melting · Hardening · Annealing

New Process for Producing Tungsten Shapes

The very high melting point of tungsten metal, 6100 F, makes its use in many applications attractive, but the forming of the shapes required is difficult because tungsten must be worked by the methods of powder metallurgy. Methods developed by *Kennametal Inc.*, Latrobe, Pa., for the manufacture of cemented carbide compositions have recently been applied to the manufacture of large tungsten shapes such as crucibles and boats for high temperature melting of refractory oxides, metals, and other materials. Other properties of tungsten which are an advantage in these applications are: high thermal conductivity, low coefficient of expansion, and, in the case of induction heating, the fact that it is a conductor.

The photographs show some of the shapes that have been made. Many more are well within the capabilities of the method. The largest crucible shown is 1.5 in. inside dia. by 3 in. deep with a flat bottom and weighs in excess of 2 lb. Crucibles with cone bottoms have also been made. Considerably larger sizes up to about 3 in. in dia. and weighing 10 lb. or more are possible.

Virtually all of the shapes made have been of very pure grade tungsten with no binder. The strength of material made in this way, while sufficient for most purposes, does not compare with that for worked tungsten. Improvement in strength can be obtained by alloying with tantalum or other



A variety of tungsten shapes are possible by the new process.

metals, which can be done in the procedure used. Some porosity is also encountered and this too can be greatly reduced by certain alloying additions where necessary.

The shapes that are possible are those which can be formed by a combination of pressing to approximate shape followed by simple machining operations on the pressed shape prior to sintering. Some limitations are also imposed by the sintering operation since support must be provided even though shrinkage takes place.

(Continued on page 1710)

Do you know that **MALLORY** *makes all these products?*

MALLORY products cover a wide territory—and so does the Mallory technical information that backs them up. Both are supreme in their field. Both are important to the business you run. If any of the publications listed at the right are not in your Engineering Library, contact your Mallory representative. He'll be glad to make you up a special portfolio.

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Vibrator Data Book (in preparation)

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Makes Wood Patterns and Core Boxes

LAST LONGER

Cerrosafe, melting range—160°-190° F. can be sprayed on wood patterns and core boxes by means of an electrically heated spray-gun.* This coating resists moisture, wear and prevents warpage. Simplifies alteration of patterns.

Cerrosafe, when cast or sprayed, reproduces fine detail. Used for making duplicate patterns and as master models for engraving machines with low stylus pressures.

*Spray gun information sent on request.

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Cerrolow-117	Melting Temp. 117° F.
Cerrolow-136	Melting Temp. 136° F.
Cerroseal	Melting Temp. 255° F.

Write for name of nearest distributor.

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A DEPENDABLE REFRACTORY CEMENT

for HIGH TEMPERATURES

You can depend upon Kellogg's Ignisite refractory cement to give superior performance under high temperature operating conditions up to 3150°F.

Its characteristics of high density, lack of shrinkage, and fineness of texture assure thin, tight joints of unusual strength; in fact a joint stronger than the brick itself. Three grades are available; Regular or Super Ignisite in plastic form for immediate use, and Dry Ignisite for use by the addition of water.

Investigate the superior qualities of Ignisite. Write for information on Kellogg's Refractory Products.

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Since tungsten is readily oxidized at elevated temperatures, these shapes can only be used in vacuum or heating equipment which provides inert or reducing atmospheres.

● A radically new type of laminating plastic, known as "C-5" resins, is announced by *Bakelite Corp.*, 300 Madison Ave., New York 17. The first of these, XJ-17694, is a surfacing material for decorative laminates. It is an xylene-toluene solution with a resin content of 50%. It has good resistance to abrasion, chemicals, craze, stain and arc. It has a broad color range and flexibility.

Synthetic Quick Setting Liquid Plastic

The *National Plastic Products Co.*, Detroit, has developed a liquid plastic known as Formalin. It is a quick-setting liquid plastic, supplied as a clear, pale, viscous mass; it is a phenol-formaldehyde condensation resin, which, when mixed with an accelerator, may be poured into suitable molds where it will harden in a short time at room temperature. It forms an opaque, ivory, solid casting, gradually developing a deep ivory color with age.

This material may be used in a variety of forms as well as in making hollow slush castings. Cast objects having undercuts may be made in rubber molds which cannot be done with the regular slow curing cast phenolic liquids because of the effect of the heat cure upon the rubber. Formalin may also be used as a cement for other phenolic plastics, as well as wood and other porous material.

Molds may be made of any suitable material such as glass, rubber, plaster, lead, tin, silver, gold, cellulose acetate or nitrate, or any material to which the liquid will not adhere in hardening.

Plaster molds and other such porous material may be used only when given a coat of Formalin black acid resistant paint and primer as a base coat for the acid resistant paint, or with other acid resistant paints.

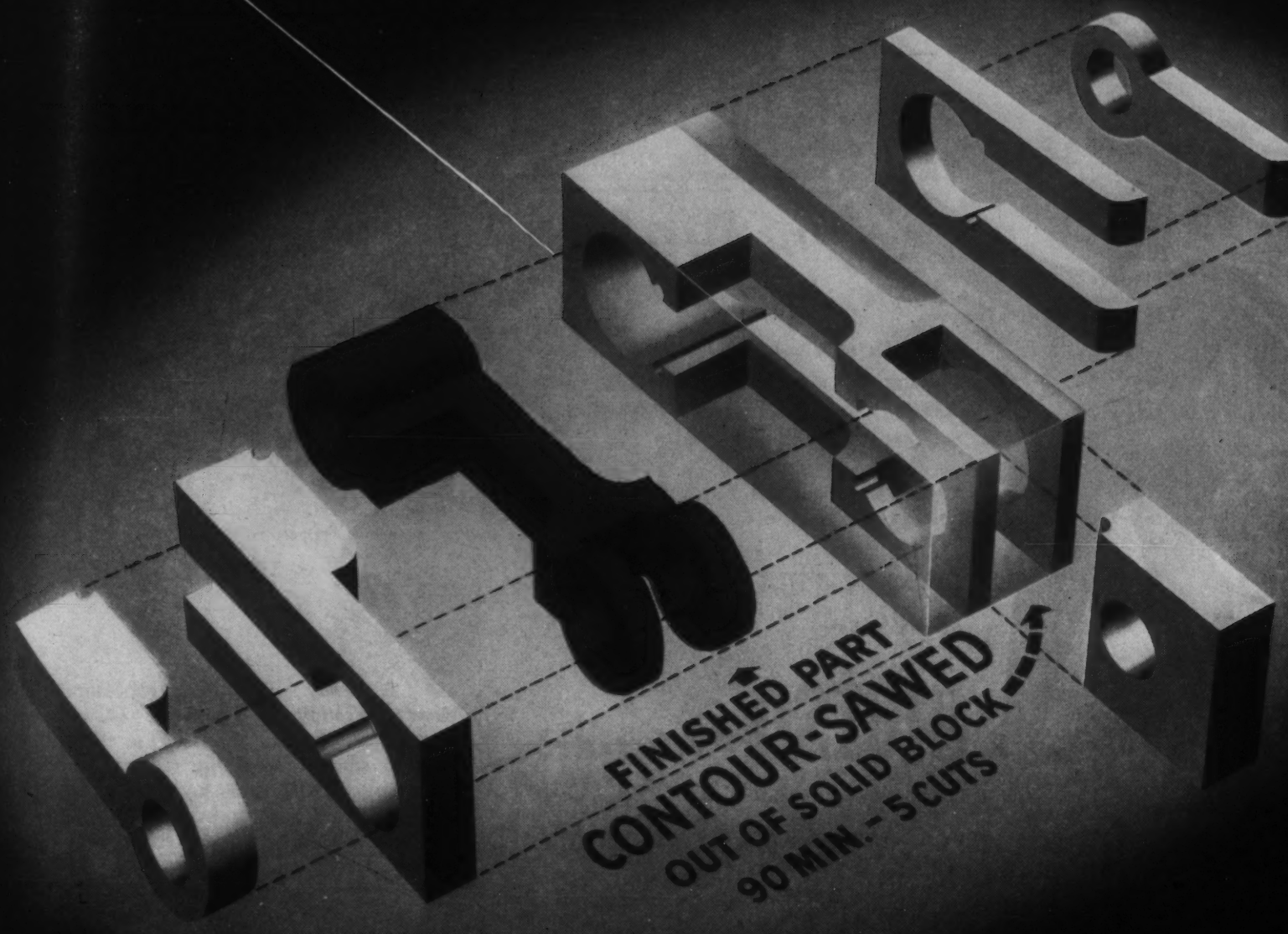
Rubber molds which accurately reproduce every detail of an object in the finished casting may be made by covering the object with several coats of a prevulcanized latex. The latex is brushed on as fast as the previous coat has dried (20 min. to an hr. drying per coat). The number of coats of latex necessary to form the mold depends upon the size and shape of the object and the thickness necessary to support the casting.

It is advisable to support the rubber mold upon a rough plaster shell to prevent distortion of the casting under its own weight in hardening. The plaster when preheated with the mold will retain sufficient heat to speed up the hardening of the plastic. To aid in stripping the rubber mold from the hardened casting, it is advisable to lubricate the mold before casting so that the rubber surface is still damp when the plastic is poured in.

(Continued on page 1712)

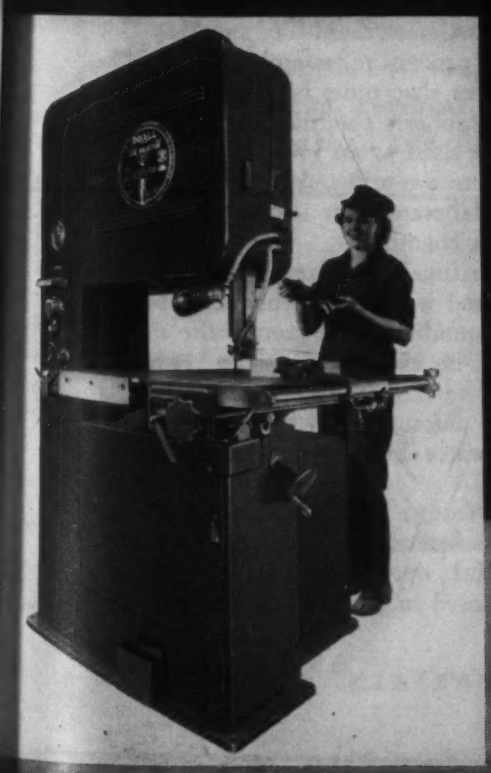
THE

METHOD OF LOW-COST PRODUCTION



Possible only by Contour Sawing—*world's fastest metal-removing process.* No other machine process can do this.

Exclusive features of Contour Sawing: 1—It is modern industry's shortcut around complex, time-taking setups. 2—Cutting tool leaves only a 1/16" slot—does not reduce to worthless chips the metal that it removes. 3—Cutting is continuous by hundreds of sharp, hard tool points on a band—there is no backstroke or lost motion. 4—Only a short training period required—not years of experience.



Like this brake lever made by Wincharger Corporation of Sioux City, Iowa, countless jobs formerly requiring castings were slow, expensive. Now Contour Sawing cuts them from stock with ease, speed and economy—all materials, even carbon and tough alloy steels, a foot or more thick.

Write for booklet "*DoALL Equals Ten Plus*" which compares Contour Sawing with ten other machine methods. It is distributed free to requests under company letterheads.

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Cleaning baths made up with Metso insure chemically clean surfaces to take flash plating that sticks tight. Here's why —Metso crystalline silicates* contain the properly balanced combination of alkali-silica. No excess alkali or silica to attack the casting or leave a deposit.

FOR DIE CASTING PLATING THAT HOLDS....

BE SURE WITH metso

Results of recent careful investigation proving this statement will interest you. Ask for a copy of the report describing the tests.

* Sodium Metasilicate U. S. Pat. 1898707.
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NEW HEAT TREATING
FURNACE
IS BEST FOR YOUR WORK!

THE LAKESIDE STEEL IMPROVEMENT CO
5418 Lakeside Avenue CLEVELAND OHIO Phone Henderson 91

The liquid plastic will not polymerize or harden unless it is mixed with an accelerator. The plastic and accelerator should be mixed in a glass, porcelain, enamel, or other such acid resistant material. The proper amount of accelerator solution depends somewhat upon the size and shape of the casting and the hardening rate desired. The best results with small castings are obtained with eight parts of accelerator for each 100 parts of liquid plastic.

The plastic and accelerator are thoroughly stirred together with a rod in a container of glass, wood, or other acid resistant material. The mixture should now stand in the mixing container or in the mold to let the small bubbles rise to the surface. The casting should be allowed to harden in the mold. This may be speeded up by placing the mold over a radiator, in an oven at a temperature of 140 to 150 F.

When rubber molds are used, the mold may be stripped from the casting while it is still in a plastic condition. After removal of the mold, the casting should be hardened further in an oven or hot box at a temperature of about 150 F for about 3 hr. This is not necessary unless castings of maximum strength and permanence are desired.

● A newly developed stroboscope by *Communication Measurements Laboratory*, New York 6, can be used for the slow-motion study of rotating, reciprocating or vibratory mechanisms and for studying mechanical stresses and strains under dynamic conditions and determining their speed or rate.

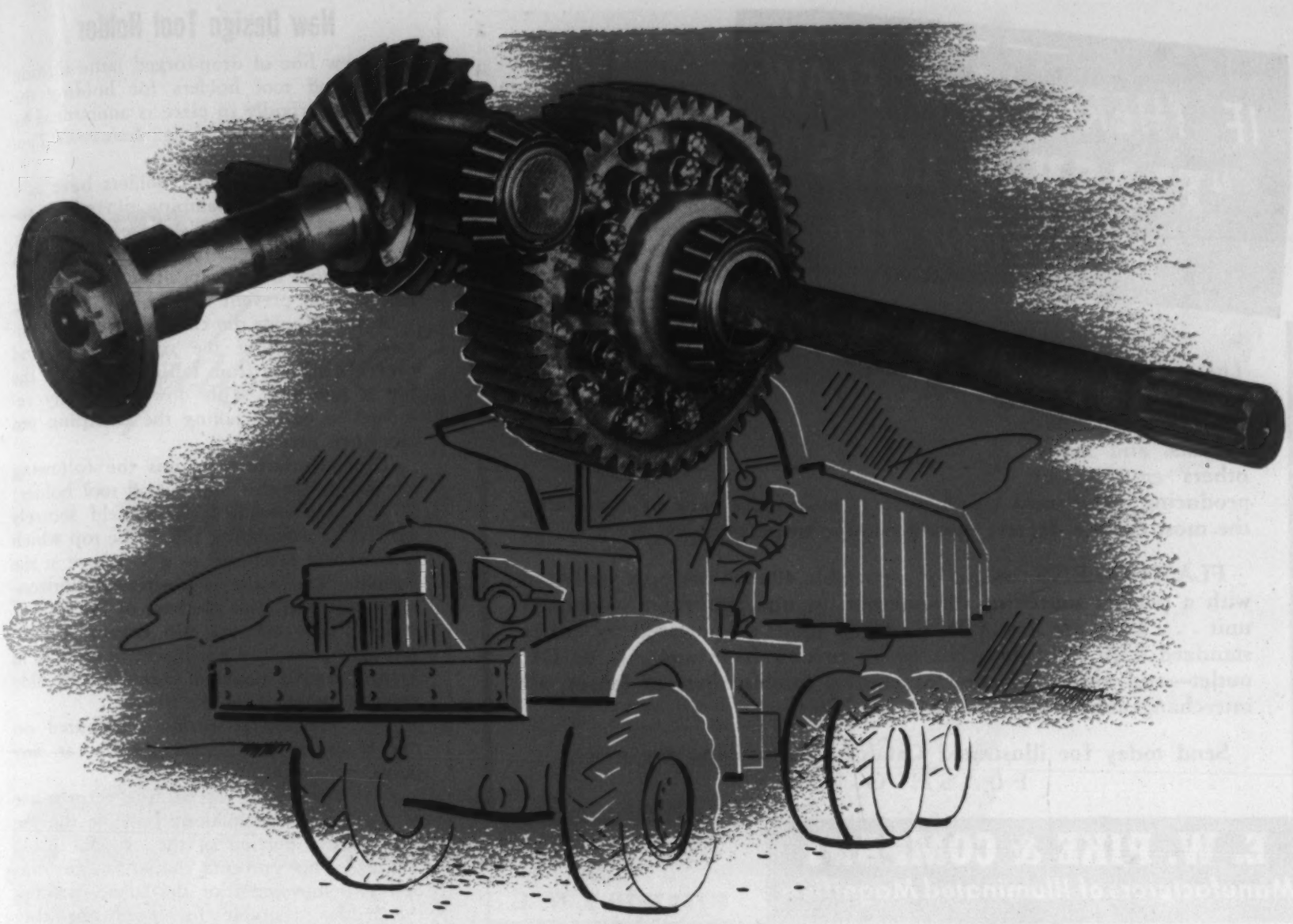
An Instrument for "Creating" Climates

A new instrument developed by the *American Instrument Co.*, Silver Spring, Md., can produce in laboratory test chambers and small-size rooms the average temperatures and humidities that prevail in most countries of the world.

Known as the Climatizer, it is useful in testing the performance, durability, etc., of devices and materials destined for use in most any climate, and is valuable for calibrating, processing, assembling, or packaging devices that must be handled under precise atmospheric conditions. The Climatizer can be used as an individual unit for application to a test chamber already in the customer's laboratory, or it can be supplied with a work chamber.

No centrifugal atomizers or spray devices are used within the work chamber to maintain humidity, consequently the use of drip pans is eliminated. The required amount of water in the Climatizer itself is maintained automatically, thus manual filling with water buckets or bottles is unnecessary.

Another feature of this instrument is the extra-length heaters which give more years of successful operation, and which are totally enclosed in protective metal sheaths.



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—no other material can equal ALLOY STEELS

Performance of vital operating parts depends upon: (1) Design, because it affects efficiency in operation—and (2) Materials of Construction, because they largely determine service life.

Design is an engineering problem—but materials of construction are our problem. And that's why we recommend alloy steels for the difficult jobs—for shafts, axles, gears, bearings, pins, valves, studs and other items.

Republic Alloy Steels are exceptionally and uniformly high in strength and toughness. Thus, they resist severe strains, shocks, reversal of stresses and temperature extremes better than any other material. They respond uniformly to all types of heat treatment—and produce hard, wear-resisting surfaces.

Hence, they last longer in service—and show a surprisingly low cost per year of safe, dependable service life.

Our experience as the world's leading producer of alloy steels is yours for the asking. We'll gladly send a Republic metallurgist to discuss your individual needs. Just set the date.

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Other Republic Products include Carbon and Stainless Steels—Sheets, Strip, Plates, Pipe, Bars, Wire, Pig Iron, Bolts and Nuts, Tubing

The new FLASH-O-LENS offers foundry-men, machinists, and many others engaged in producing metal parts an efficient, economical means of examining the most minute defects during routine inspections.

FLASH-O-LENS consists of a portable 40x microscope combined with a perfect source of illumination in one convenient, compact unit . . . They are available in several models—powered by either standard flash light dry cells or by current from any AC or DC outlet—and with a selection of various combinations of lenses, all interchangeable in the one lens housing.

Send today for illustrated Catalog O describing the new
FLASH-O-LENS

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Manufacturers of Illuminated Magnifiers
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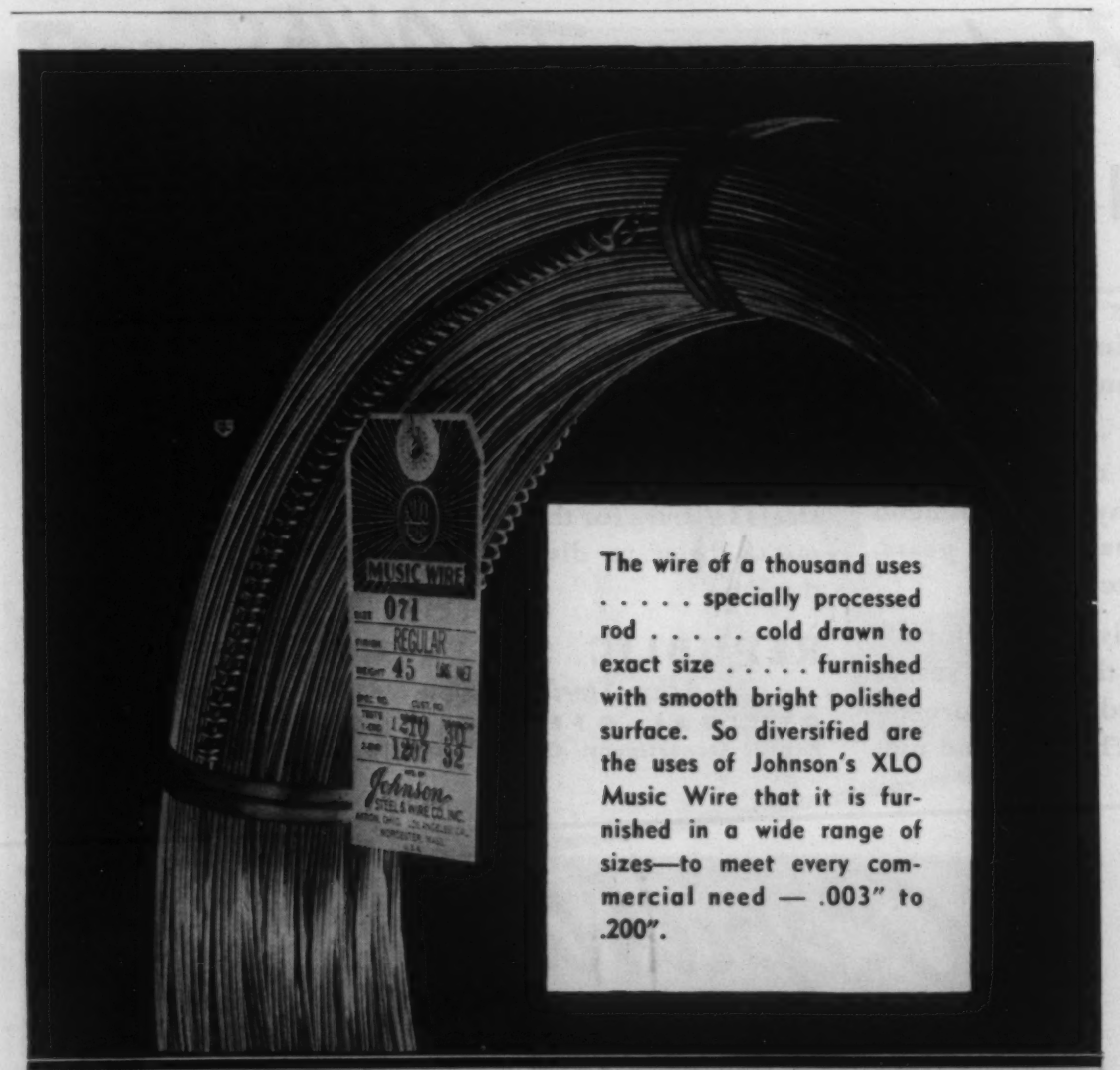


The wire of a thousand uses . . . . . specially processed rod . . . . . cold drawn to exact size . . . . . furnished with smooth bright polished surface. So diversified are the uses of Johnson's XLO Music Wire that it is furnished in a wide range of sizes—to meet every commercial need — .003" to .200".

JOHNSON STEEL & WIRE CO., INC.
WORCESTER 1, MASSACHUSETTS.
NEW YORK AKRON DETROIT CHICAGO LOS ANGELES TORONTO

New Design Tool Holder

A new line of drop-forged lathe turning and cut-off tool holders for holding the cutting bit rigidly in place is announced by the *Cooper-Bessemer Corp., Industrial Tool Div.*, Mount Vernon, Ohio.

The new turning tool holders have as a patented feature a clamping pin which engages the bit for nearly its entire length. It contains two flush-type set screws which lock the tool bit into position with a vise-like grip to prevent slippage.

A dowel holds the clamping pin in position for inserting the cutting tool, and prevents the pin from falling out when the bit is removed. This dowel is easily removed to permit taking the clamping pin out when necessary.

The manufacturer claims the following advantages for this new cut-off tool holder:

(1) The cut-off blade is held securely vertical by a clamping pin at the top which is accurately machined to a V-groove at the bottom. The blade is positioned horizontally and parallel to the base of the holder.

(2) The clamping pin engages a considerable portion of the blade, holding it to a true cutting position regardless of side pressure imposed on the blade.

(3) Pressure is evenly distributed on the blade without undue strain at any point.

(4) The method of holding permits use of a shorter blade, making possible the use of a greater portion of the original blade lengths. This prevents chatter or any undesirable movement of the blade, making the holder desirable for work requiring close precision.

(5) The blade can be taken from the holder and replaced without changing the adjustment in the tool post.

● The *Massie Manufacturing Co.*, Minneapolis 13, has announced the development of a cleaner for sandpaper. Known as "Sand Re Nu," the liquid will dissolve the particles which have lodged between the abrasive grains and leave the sandpaper with a new cutting edge.

New Surface Pyrometer

A new surface pyrometer has been designed by the *Pyrometer Instrument Co.*, New York. It is self contained, portable, compact, and quick acting. Constructed in a shock, moisture- and dust-proofed shielded steel housing, it is immune to external magnetic influences. It has a 4¾-in. dia. indicator with a 4-in. direct reading scale.

An internal automatic cold end junction compensator is standard equipment with this instrument. A choice of eight different thermocouples and two types of extension arms, all interchangeable without adjustment or re-calibration, together with a selection of five different temperature ranges from 0-300 F to 0-1200 F, makes this instrument applicable to many metallic or nonmetallic surface temperature problems.

The interchangeable thermocouples also have been designed to eliminate temperature gradient errors, and all thermocouple wires have been checked to ±2 F accuracy.

Timken's making *light-weight*, heavy-duty axles using Alcoa Aluminum

Series S-200-P Double-Reduction Drive Rear Axle with aluminum axle housing, hubs and brake shoes. Product of The Timken-Detroit Axle Co.

220 pounds lighter in weight than a comparable unit of heavy-metal construction! Think what this means: Less wear on tires, easier riding qualities, longer life for chassis and body parts; all these add up to greater operating profits.

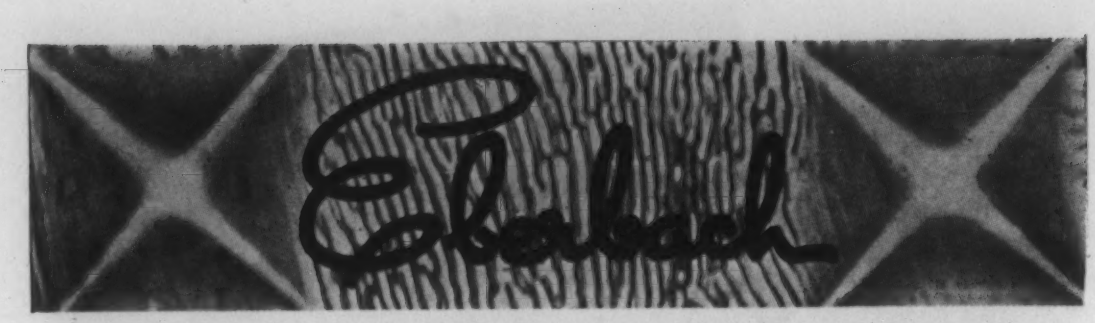
Proved dependable by exhaustive laboratory and road tests, the S and U Series of rear axles have taken their places in Timken's standard line. Fleet operators can now order equipment with these lighter weight axles.

To manufacturers of other products — Alcoa offers the same co-operation as that given Timken during their development of these new axles. Assistance in the design of a product using an aluminum alloy — testing of aluminum parts to assure maximum dependability — getting those parts into production; all these are at your command through Alcoa, world's greatest fund of aluminum know-how.

For this help, call the nearby Alcoa office. Or write ALUMINUM COMPANY OF AMERICA, 2162 Gulf Building, Pittsburgh 19, Pennsylvania.

ALCOA FIRST IN **ALUMINUM**

ALCOA ALUMINUM



MICRO HARDNESS TESTER

determines hardness of materials or metallographic constituents which cannot be measured by standard methods.

●

The most valuable feature of the Eberbach Hardness Tester is that with it, you can accurately gauge the hardness of single grains in alloys, plating, nitrided and cyanided layers, and minute particles.

●

The tester is equipped with an indenter unit designed to mount on any metallurgical type microscope. An accurately ground diamond indenter permits measurement directly in diamond pyramid units, instantly convertible to other systems. Data may be taken visually or photographically.

for details . . . write

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EMPIRE STATE BUILDING, NEW YORK 1, N.Y.

Tool Grinding Fixture

The *George Scherr Co.*, New York 12, announces the development of a new tool grinding fixture for the precision grinding of lathe tools, screw machine form tools, shaper, planer, milling machine or any angle cutting tools.

The fixture works on a patented principle involving the use of compound angles. It is placed on the magnetic chuck of a surface grinder and is held in place by the magnetic power of the chuck, thus eliminating the uncertainties of hand grinding. It is graduated by degrees up to 90; angles both left and right may be readily obtained. The rake angle is ground on the tool by means of a tipping block, which gives 3, 5, 7 and 10 degree clearance.

The principle involved employs four surfaces of the tilting block so that when the three degree angle is desired the block is tipped to read three degrees and the block automatically lines up with the three degree angle surface on the main casting. In like manner, the 5°, 7° and 10° clearance angles are obtainable.

The tool may be used to grind tools from ⅛ in. to 1¼ in., and is widely used for carbon, alloy and tungsten carbide tool bits. Both inside and outside threading and recess tools as well as form tools may be ground.

● A new mercury temperature regulator intended for accurate control of temperatures in water, oil, air baths, ovens, etc., at any temperature within the setting range from —30 F to +500 F has been developed by the *Washington Glass Laboratory & Instrument Co.*, Washington, D. C.

Clamping Jigs

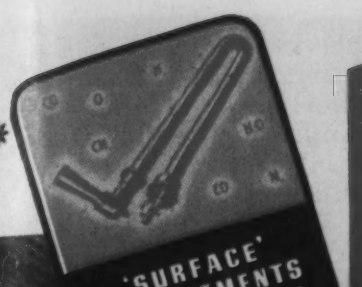
Two new clamping jigs to tool very small parts have been introduced by *N. A. Woodworth Co.*, Detroit. The working parts are made of hardened and ground alloy steel, and can be assembled or dismantled rapidly.

The moving parts operate in an oil bath which keeps chips and cutting oils from contact with any of the internal parts, in this manner avoiding damage and excessive wear.

Several safety features have been incorporated in the design. No movement of working parts is possible without action of the operating lever. The tray is positively clamped at any location in up or down strokes.

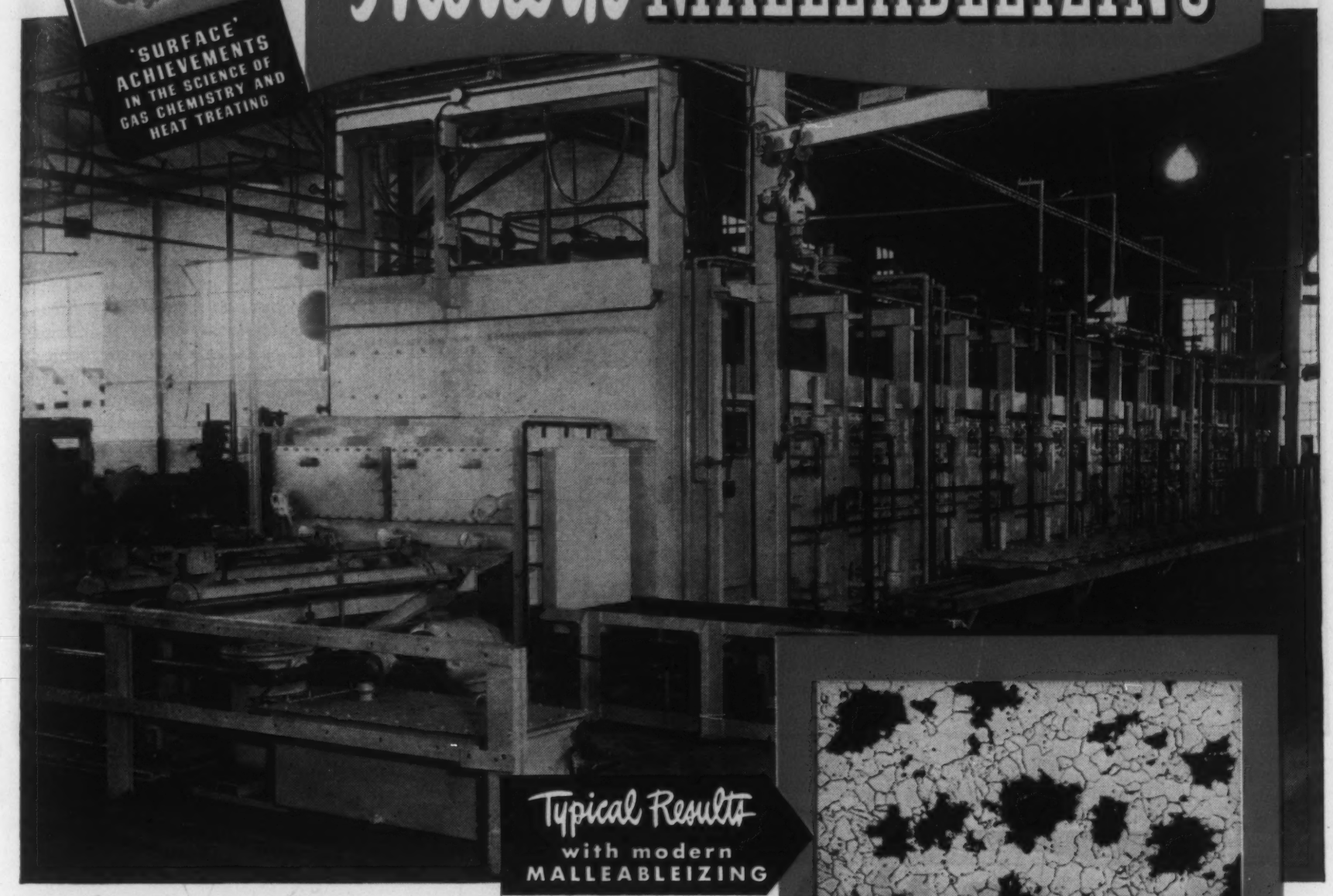
The jigs are available for working spaces of 1 in. by 1 in. by 1 in. and 1 in. by 2 in. by 1 in.

● A "Guide to the Anti-Corrosion Procedure of P.S. 300-4," the Federal specification covering the preparation for storage of production equipment, has been issued on a large card by the *F. E. Anderson Oil Co.*, Portland, Conn. A major portion of the rust-proofing can be done where the machine stands in its production position. The equipment is then skidded and removed to an area where subsequent operations are completed.



'SURFACE' ACHIEVEMENTS IN THE SCIENCE OF GAS CHEMISTRY AND HEAT TREATING

Modern MALLEABLEIZING



Typical Results with modern MALLEABLEIZING

Photomicrograph of 2.35 Carbon, 1.35 Silicon iron malleableized on a 33-hour continuous cycle. Tensile strength, 52,100 psi. Elongation 16%. Brinnel 143.

The modern, continuous malleableizing furnace, for short cycle annealing, requires close control of the atmosphere. A prerequisite is tightness of construction as well as tightness of all closures such as doors and vestibules. Fully as important are the heating elements. They should be capable of close control and should distribute the heat uniformly, top and bottom. This is particularly important where the cycle calls for rapid changes of temperature. The 'Surface' Radiant Tube makes it possible to heat or cool with the same element. This adds greatly to the flexibility of the furnace.

The roller bottom tray, specifically developed for 'Surface' Malleableizing Furnaces, contributes in a big way to the ease and fool-proofness of operation.

'Surface' also offers radiant-tube heated, tight-fitting malleableizing covers for rapid batch annealing of long, bulky, or heavy castings.

'Surface'

* SPECIAL RADIANT-TUBE HEATED ATMOSPHERE FURNACES FOR Gas Carburizing and Carbon Restoration (Skin Recovery), Clean and Bright Atmosphere Hardening, Bright Gas-Normalizing and Annealing, Dry (Gas) Cyaniding, Bright Super-fast Gas Quenching, Atmosphere Malleableizing, Atmosphere Forging, and Specific Effects upon Metal Surfaces.

SURFACE COMBUSTION CORPORATION • TOLEDO 1, OHIO

"ROCKWELL" HARDNESS TESTER

New Catalog RT-46

This is not a catalog primarily intended for purchasing departments as it gives only technical information, but it does show by description and illustration our very complete line of hardness testing equipment, including the "TUKON" tester and the new "ROCKWELL" Universal Testing Unit.

Several pages are devoted to making clear the difference between, and the difference in intended applications of, the normal type of "ROCKWELL" Tester and the "Superficial" machine. You hear more and more about the "Superficial" each year.

Just one of over 50 illustrations in the 1946 catalog.

This catalog is of 40 pages with over 50 illustrations. It is only 7½" x 6" and printed by offset process on light paper. Do not hesitate to ask for it because you may not need more testing equipment. We would like everyone at all interested in the subject of hardness testing to have a copy.

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● Tipping the scales at 228.7 lb., a huge piece of self-lubricating Oilite bronze bar stock, made from powdered metals, establishes a new world weight mark, some 84½ lb. heavier than the previous record, also held by *Chrysler Corp.*'s Amplex Div., Detroit 31. It is designed to be machined into spherical bearings for dynamometers on high torque aircraft engine test applications.

Welded Press Developments

Warren City Mfg. Co., Warren, Ohio, have announced the development of a new line of all-steel welded presses. The presses are designed for the production of stampings in the automotive, refrigeration, furniture, storage container and other industries.

This line of presses includes mechanical open-back inclinable presses, ranging in size from 50 to 150 tons capacity, a series of mechanical and hydraulic metal-working presses, with capacity from 100 to 1200 tons, and mechanical press brakes in sizes from 100 to 500 tons and designed to handle lengths up to 24 ft.

The designs call for eccentric gear models in both mechanical and hydraulic types. The press frame (solid or tie-rod) will be welded steel, providing the inherent rigidity essential to maximum die life. Weldments will be stress relieved to prevent locked up stresses and future misalignment.

The slide will be welded steel, guided in long bronze-lined gibways, to further prolong die life. The slide will be adjusted by a motor equipped with a magnetic-type brake for automatically locking the adjustment. Pneumatic cylinders will counterbalance the weight of the slide and dies.

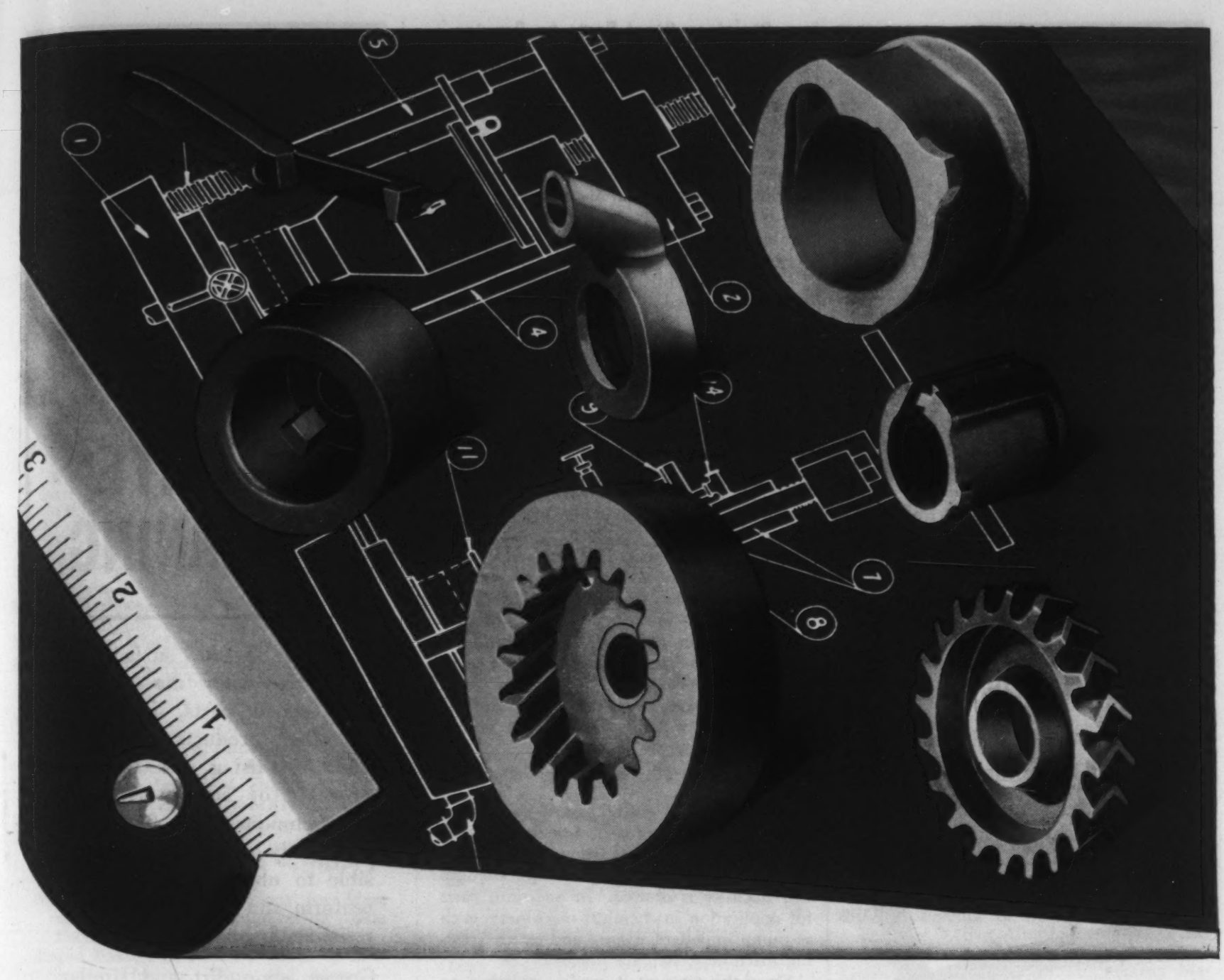
● Increased industrial use of electronic recorders has been made possible by stepping up chart speeds of "Electronik Pyro-Potentiometers." Fast speed electronic models, single or multiple point, will have internally mounted gears for speeds of 10, 20, 30 and 40 in. an hr., states the *Brown Instrument Co.*, 4431 Wayne Ave., Philadelphia 44.

Flexible Shaft Grinder

The *Spring Specialty Co.*, Maywood, Ill., announces a new, high-speed, direct connected flexible shaft grinder. It operates at a free speed of 18,000 r.p.m. It has a special type ball bearing spindle; this spindle has not only an integral, key operated ¼-in. collet but can also be provided with auxiliary insert reducing collets which accommodate ⅛-, 3/32- and 3/16-in. arbors.

The motor is a ¼ h.p., ac-dc type, provided with an end ring for suspension and rubber footed base for bench use. A variable speed rheostat or line switch can be supplied.

Many special arbors, mounted wheels, rotary files, rubber drums, polishing chucks, etc., are available as accessories.



A Better Basic Design

THROUGH MICROCAST

MICROCAST PRECISION CASTINGS PROCESS

Forward looking design engineers in their constant effort toward product improvement have found the means to a better basic design through the MICROCAST PROCESS. With MICROCAST it is now possible to utilize the unusual properties and many advantages of a whole new range of alloys—Vitallium, Stellite, stainless and tool steels which often in the past could not be exploited because their use would entail prohibitive production costs.

MICROCASTINGS of these high melting point alloys may be quantity produced in intricate shapes and designs, with such sound structure, surface smoothness and precision tolerances that little or no machining is required.

MICROCAST in industry has almost limitless applications. For example, in the automotive field many valve parts, rocker arms, cams, carburetor parts and small gears for pumps and timers can be mass produced by MICROCAST. It has proven particularly successful in producing specialty blades by the millions for power development units such as turbines on jet propelled aircraft and turbo-superchargers.

Consider MICROCAST in your own product plans particularly for small parts where high tensile strength or resistance to wear, corrosion and high temperatures is required. A better basic design through MICROCAST may be the means to a better product for you.

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MICROCAST

More complete information on MICROCAST is contained in a new booklet published by the Austenal Laboratories, Inc. originators of the MICROCAST PROCESS. This valuable new booklet is fully illustrated and describes many industrial applications for MICROCASTINGS as well as giving a step by step description of the Process itself. Write for your copy today.

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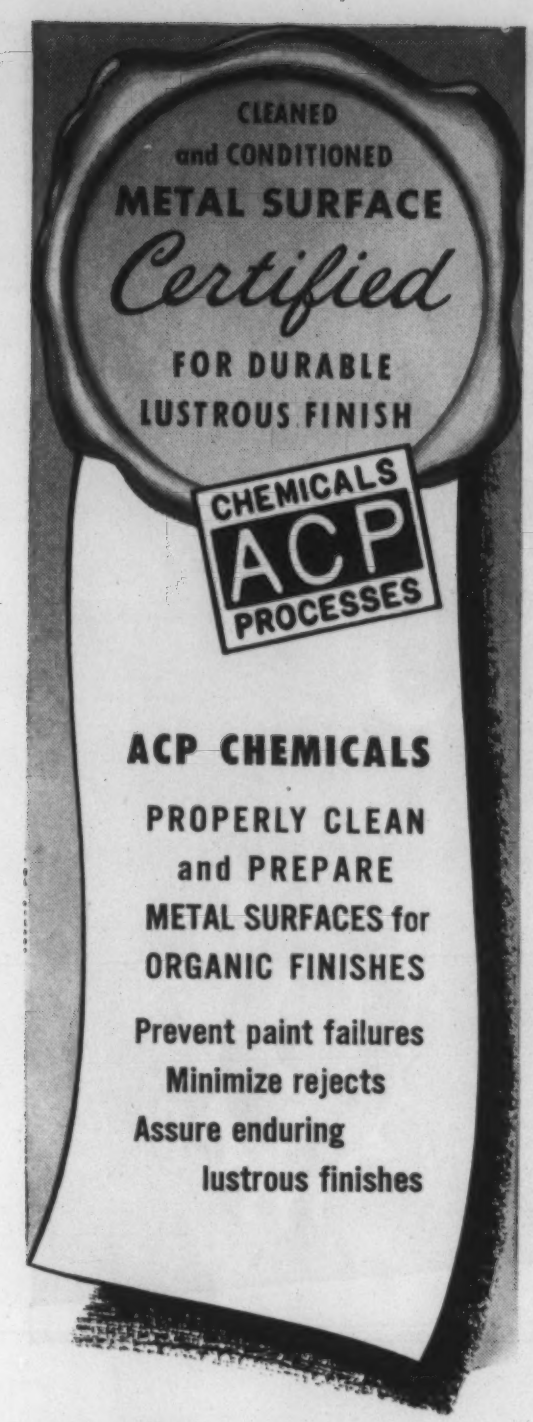

ACP CHEMICALS

PROPERLY CLEAN and PREPARE METAL SURFACES for ORGANIC FINISHES

Prevent paint failures
Minimize rejects
Assure enduring lustrous finishes

COLD SPRAY-GRANODINE produces a dense smooth zinc phosphate coating that protects steel and paint for a durable, lustrous paint finish.

THERMOIL-GRANODINE creates a heavy coating of iron and manganese phosphate which when oiled retards corrosion and prevents excessive wear on friction surfaces. When painted provides unusual protection.

DURIDINE 210 B (formerly 210 B Deoxidine) assures proper cleaning and a thin, tight and relatively hard phosphate coating so essential to a bright enduring paint finish.

DEOXIDINES — Phosphoric acid metal cleaners. Remove rust and rusters and prepare metal surfaces properly for lasting paint finish.

LITHOFORM — a phosphate coating that bonds paint to galvanized, zinc or cadmium coated surfaces.

American Chemical Paint Co.
AMBLER ACP PENNA.

Stainless Steel Parts by Powder Metallurgy

While powdered metal parts of a variety of metals and alloys have assumed a position of great industrial importance, stainless steel has hitherto been only a laboratory curiosity. The *Micro Metallic Co.*, Forest Hills, N. Y., offers on a mass production scale stainless steel parts by the powder metallurgy process.

Compared with powdered metal parts of other metals and alloys, stainless steel offers a number of important advantages in addition to greatly increased resistance to corrosion. One of these is extremely high strength coupled with ductility (55,000 to 65,000 psi., 10% elongation).

The manufacture of stainless steel parts by the powder metallurgy method is also made attractive by the high price of stainless steel bar stock; even when only a comparatively small amount of metal is machined from the part by conventional methods, a savings in raw material costs is shown by the powder metallurgy method. Since stainless bar stock is more difficult to machine than the other commonly used metals, the elimination of this operation in the powdered metal product is an even greater advantage.

The advantages common to the powdered metal process, when applied to other metals, are also shared by stainless steel. These advantages include mass production at low unit cost.

The process is well adapted to making machine parts where corrosion resistance of self-lubrication is an advantage, or where the particular combination of high strength and ductility is desired. In addition, parts for application in chemical machinery, such as pump impellers, dyeing and textile treating machinery, etc., are practical.

Since the product is readily polished to a high finish, its application in marine and sanitary hardware and in costume jewelry, furniture accessories, watch cases, etc., should receive serious consideration.

Rotary File and Die Grinder

A small and lightweight pneumatic file and die grinder is announced by the *Ideal Industries, Inc.*, Sycamore, Ill. It is only 6½ in. long by 1½ in. dia., weighs but 16 oz., and it is rated at ¼ h.p., 19,000 r.p.m. (90 psi.). Maximum speed is 25,000 r.p.m.

The motor is a vane type and it maintains its speed even under heavy loads. The harder it is worked, the cooler it becomes. All dust and chips that may be formed are blown away by the exhaust of air from parts at the chuck end of grinder, leaving work clear for observation at all times.

The collet chuck is of the double grip type so that the flexible sleeve securely holds both oversize and undersize shanks. The standard chuck, as furnished, is made for tools having ¼-in. shank, or flexible sleeve may be obtained for ⅛-in. of 3/16-in. shank.

When Chromating Zinc

Prepare Surfaces with

SAFE OAKITE CLEANING

UNLESS the surfaces of zinc alloy die castings, zinc plated parts, galvanized or other products on which you are using the Chronak process (or similar chromating techniques) are first made chemically clean, it is impossible to obtain a satisfactory, uniform and lasting corrosion-resisting finish.

Grease, shop dirt and similar foreign matter must first be removed. And that's where Oakite materials and procedures prove themselves! Not only do they completely and rapidly rid zinc surfaces of these accumulations, but they do the job safely.

SEND FOR FREE DIGEST!

Yours . . . a fact filled twelve-page digest describing correct methods of surface preparation for zinc die castings. Also includes formulas for cleaning other type metal die castings or conditioning surfaces to receive chemical, organic or electroplated finishes. Write for your FREE copy TODAY!

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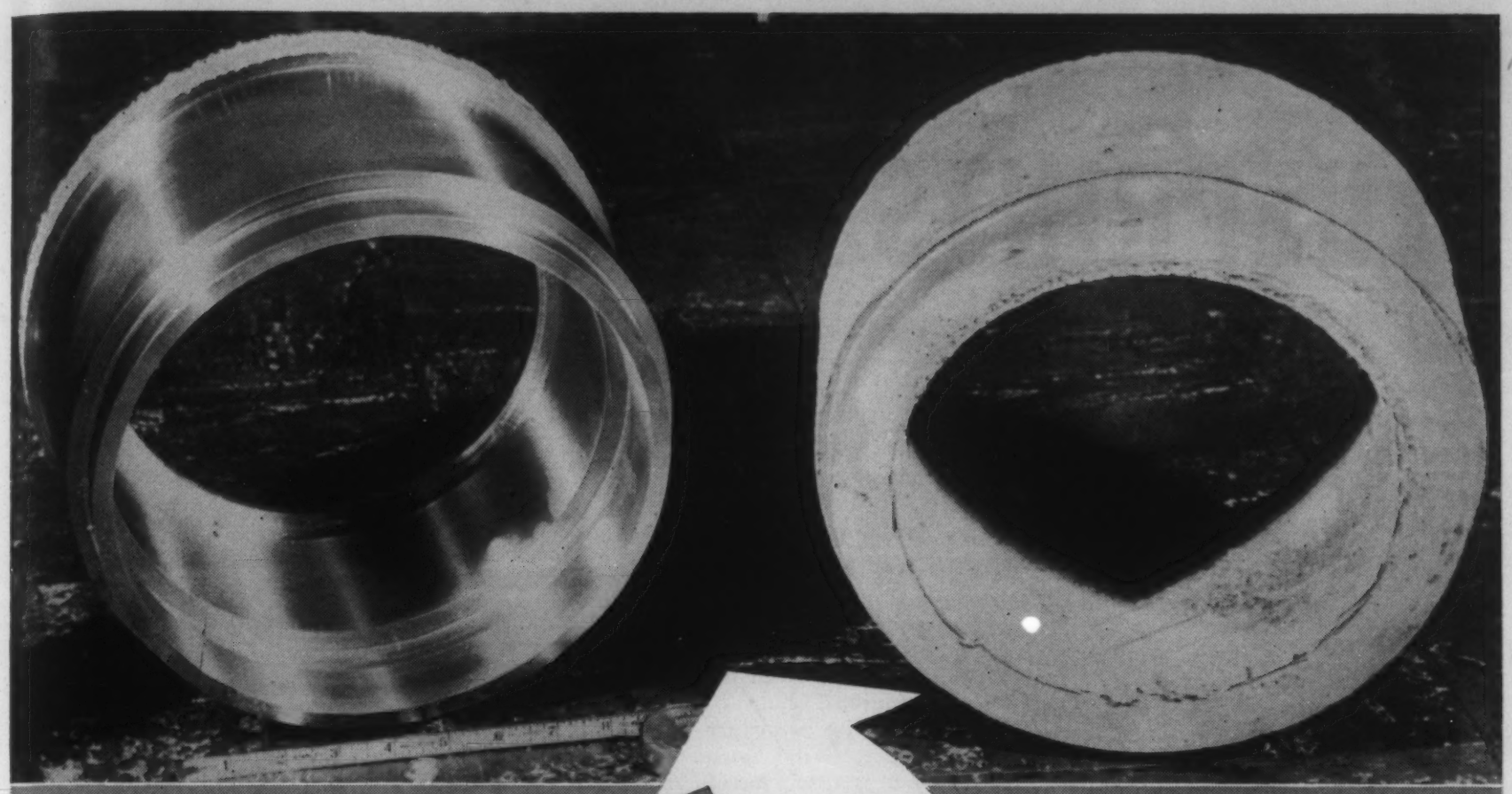

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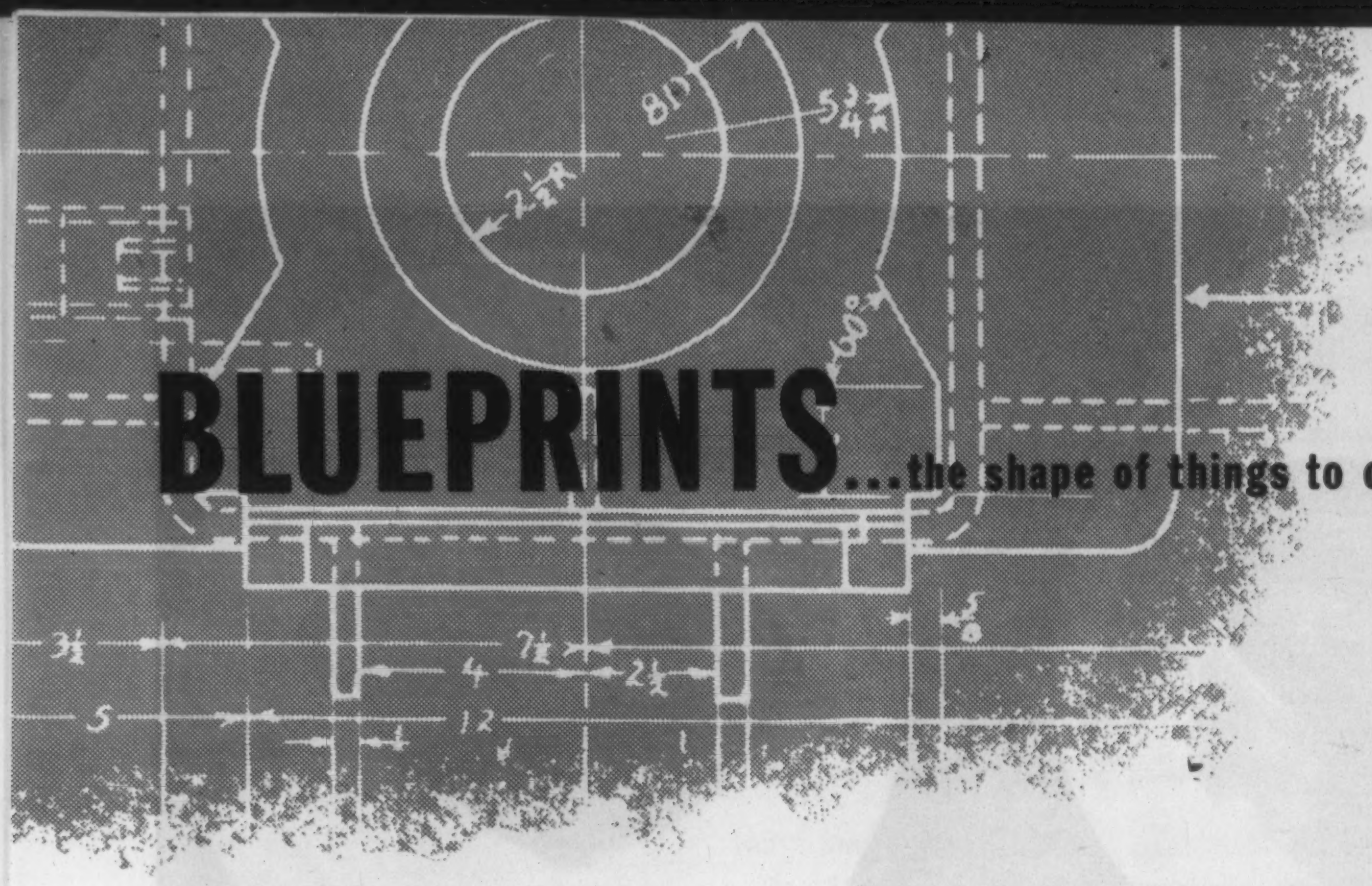


BLUEPRINTS...the shape of things to come

Aluminum for Bearings

Several automotive companies are working along with metal producing and fabricating plants in pilot plant production of aluminum alloy bearings. Thus, one likely combination is aluminum with 6% tin which is said to give characteristics comparable with silver bearings. Which is all to the good since silver available for industry is extremely scarce while aluminum is most plentiful. These aluminum bearings have been described as a "very hot subject" —which is not to imply the bearings overheat.

New Austempering Application

One of the outstanding peacetime applications of austempering, used widely for precision hardening of ordnance parts, will be the heat treatment of automobile bumpers in salt bath furnaces, using constant temperature transformation (or isothermal) treatments such as austempering.

Dielectric Heating for Sealing

Dielectric heating will play an ever more important role in joining two plastics together to form seams. It might be termed "electronic sewing", which indeed is what one of the makers of equipment will call it. The high-frequency electrical energy does not become heat until after it enters the work material. The electrodes remain cool while the heat is "born" in the material itself and is conducted away by the cool electrodes. Uniformity of heating, pressure and cooling makes for perfect seals. In one machine the upper electrode will ride up and down rapidly, each pressure stroke overlapping the previous one; another will use roller electrodes, making a continuous seam of any length or contour.

Slow Motion Industrial Camera

One of these days it will be possible for the average manufacturer to see with his own eyes what takes place in the millionth of a second when a piece of metal, for instance, finally ruptures from applied stress. Super slow motion pictures were evolved during the war with cameras devised that take 8,000 pictures per sec., magnifying time duration 500 times, thus stretching a second to 8 min. on the screen. The new camera for industrial purposes will not use a conventional shutter. Rather, a continuously rotating prism just behind the lense projects successive images. A rocket at 1,000 ft. per sec. merely ambles over the screen at under 3 m.p.h.

Self-Casing Grinding Wheel

An ordinary type grinding wheel can be given a hardness comparing with a diamond wheel. The process coats the grain of the abrasive so that when it goes to work the coating changes to a "case" that reduces sintered carbide tools, etc. rapidly. Such wheels will rough out or precision grind tool steels, cast iron, brass and other alloys. The wheel is thus "self-casing".

Two-Engined Jet Plane

One of the latest jet propelled aircraft ideas is two jet engines, one in the front, the other towards the rear. The latter produces thrust directly behind the airplane, as in the conventional jet plane. However, the jet thrust from the forward engine is directed through the floor of the plane, directed both downward and towards the rear. Thus, it tends to keep the airplane in the air as well as contributing to the forward motion of the plane.

Fumeless Pickle

Trouble is with most metal "pickles"—they give out acid mist or toxic fumes and the worker feels that his teeth are being eaten up. Look for a pickle shipped as a solid and changed to a solution at the plant—and with no nasty fumes emitted.

Silver for "Solderable" Base

A new coating composition containing finely divided silver particles to be spread upon almost any base material to form a "solderable" base for attaching metals may be in production one of these days. Several silver solutions have come out in recent years for firing onto a glass or ceramic base but they must be fired at around 1000 F, which is destructive. In this newer compound the silver particles are combined in a solution of butyl methacrylate polymer dissolved in naphtha, butanol, or xylene. It will be applied by brush, spray, etc. to virtually any permanent base.

Three Dimension Fluoroscope

Inventors in the field of X-ray have brought out a "stereofluoroscope" which will see through an object in three dimensions, equipment that has possibilities in both industry and medicine. It should be able to locate depth of the focal point under scrutiny in various materials, including metals, as well as parts of the human body.

Phosphorescent Plastic Handles

There's an old gag of vaudeville days about "feeding baby garlic so you can find him in the dark". The same basic idea is involved with tools with phosphorescent plastic handles. They will at least be easy to find in a hurry.

Recipe for Making a Boat

Would you like a small boat? Then take a form resembling an ordinary boat hull. Tailor-up a cloth "suit" and fit it over the hull structure. Impregnate the cloth with Thalid resin. Slip a rubber bag over the entire assembly and apply pressure. Bake well. Maw, can I go out in the boat—I'll stick close to shore? Naw, it ain't rough today.

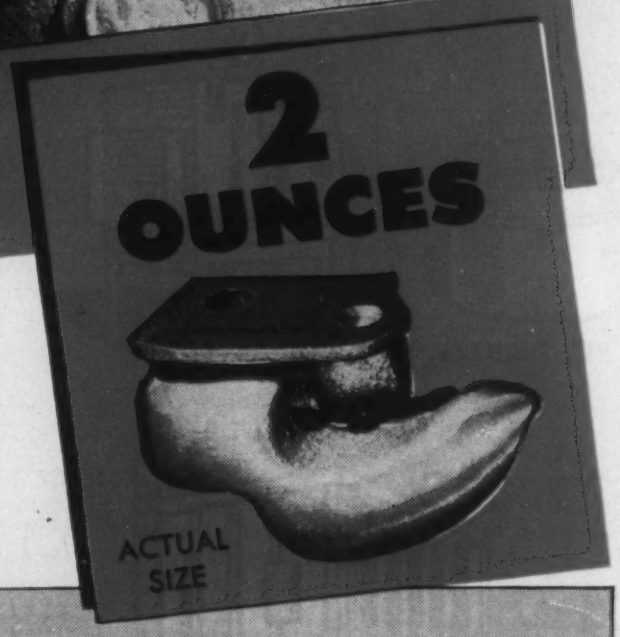
Magnesium Crank Cases

We'll be seeing magnesium alloy crank cases in automotive equipment. A large Diesel engine case made in England weighs only 600 lb. In an automobile it will promote better running efficiency, longer tire life, higher braking efficiency, lower fuel consumption and heavier payload.

Correction on Tin Coatings

In our January issue, we published an item in this department concerning a thin coating of tin under steel before painting to protect against corrosion. We said erroneously that experiments ranged from a tin coating of ½ oz. to 2 oz. per sq. ft. The correct statement is: "per base box of 100 lb."

68 TONS or..

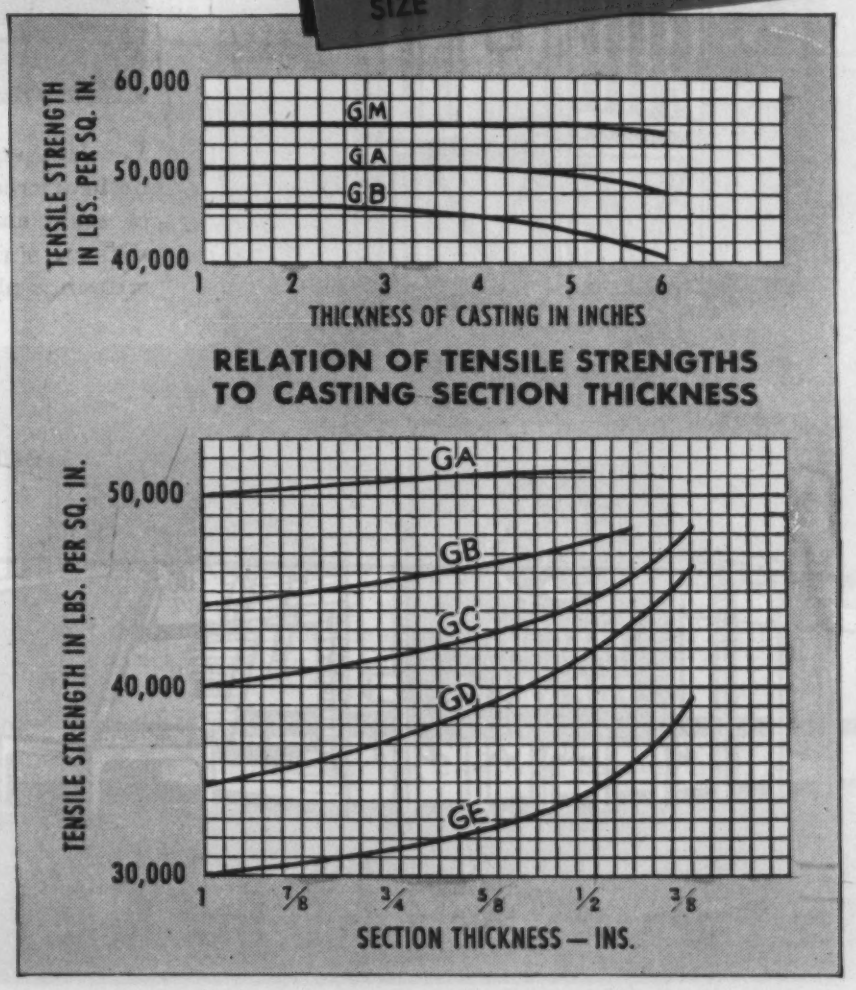


MEEHANITE ASSURES BETTER PROPERTIES!

The 68-ton Meehanite Casting illustrated forms the bed of a stone crusher capable of reducing large pieces of rock to crushed stone. Meehanite was selected because it provides the required high strength and wear resistance. Since the casting was machined at the quarry easy machinability was required.

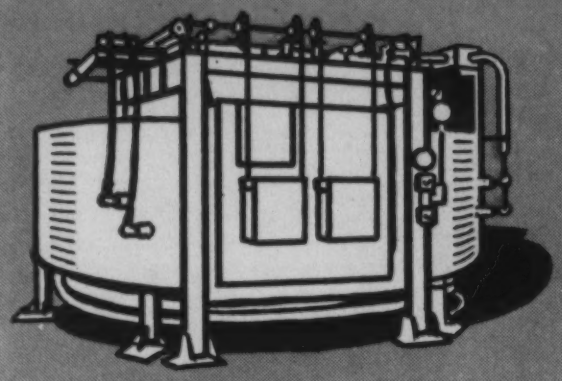
In the small 2-ounce shuttle part, Meehanite manufacturing techniques provide the metallurgical control of structure and the "know how" in the other elements of foundry practice necessary to produce this casting in quantity and with the required characteristics.

Write for our new four-page bulletin "Meehanite Quality Control Assures Uniform Dependability."

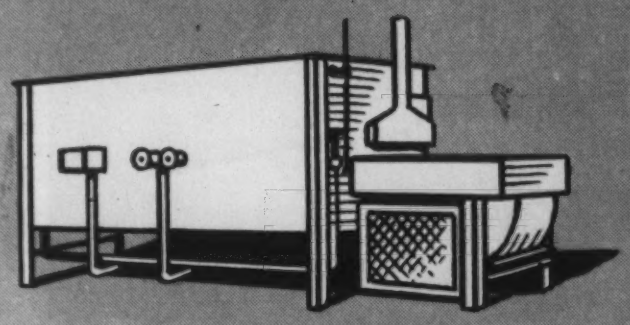


MEEHANITE

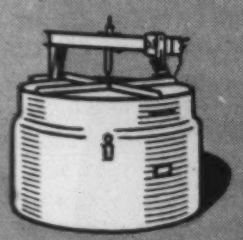
Pershing Square Building, New Rochelle, N. Y.



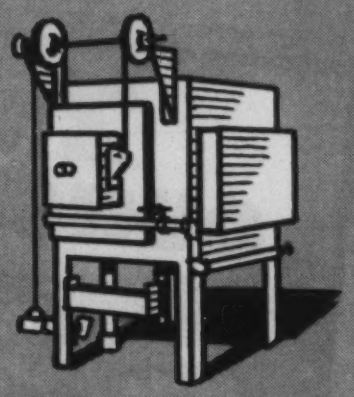
ROTARY-HEARTH FURNACE



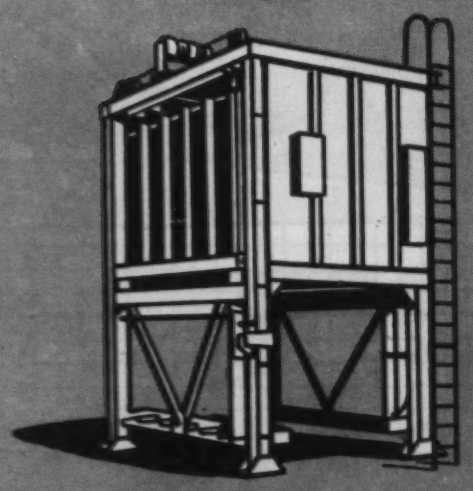
CONVEYOR FURNACE



PIT FURNACE



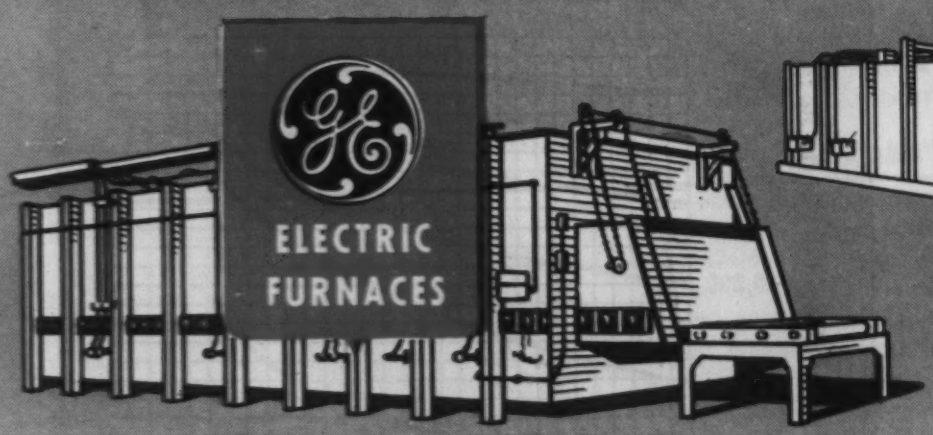
BOX FURNACE



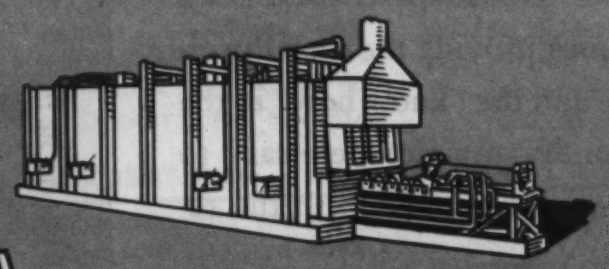
ELEVATOR FURNACE

HOW TO HEAT-TREAT HIGH-SPEED STEELS *without decarb*

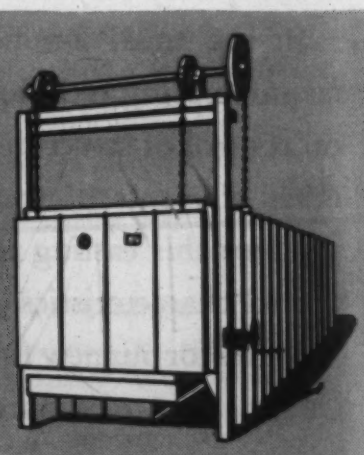
1. High-speed steels of all types—moly, tungsten, or cobalt—can be heat-treated in G-E electric box furnaces without the formation of scale and with *no* decarburization. A typical installation consists of a preheat and a high-heat furnace, as installed here in an ordnance plant.



ROLLER-HEARTH FURNACE



PUSHER FURNACE



CAR-BOTTOM FURNACE

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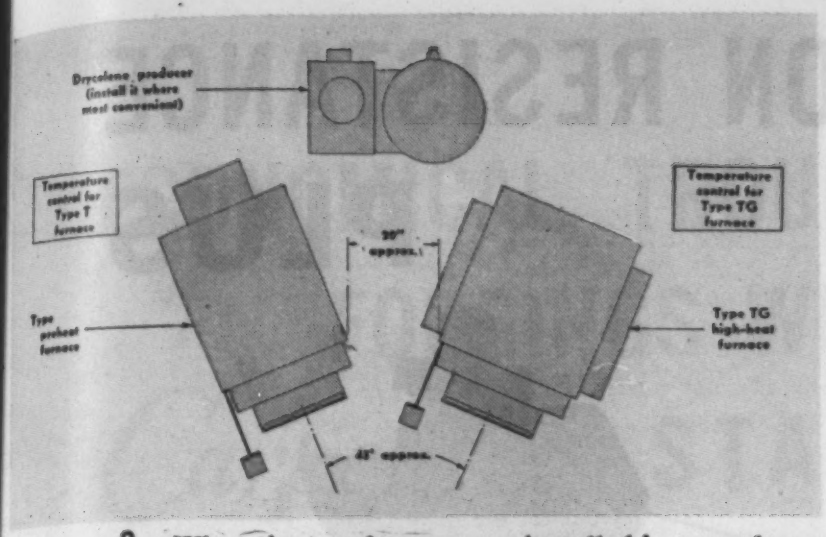
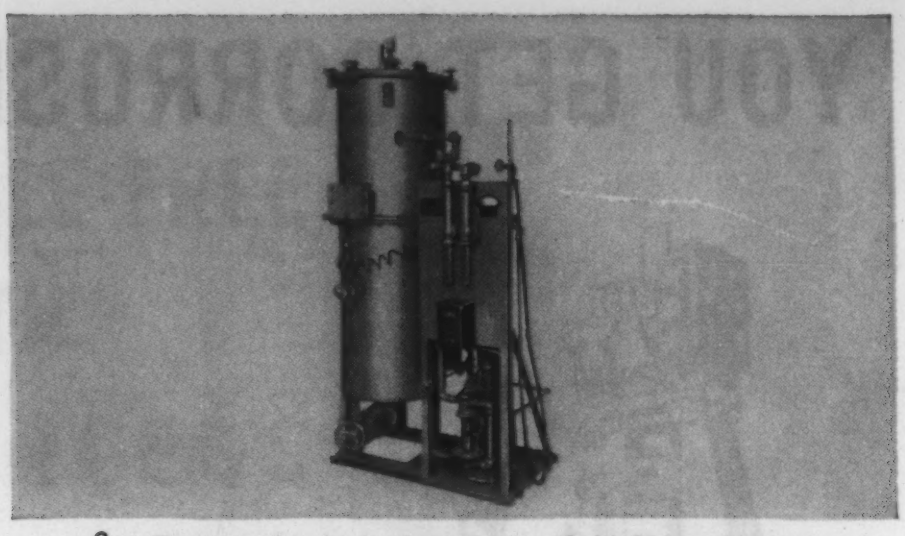
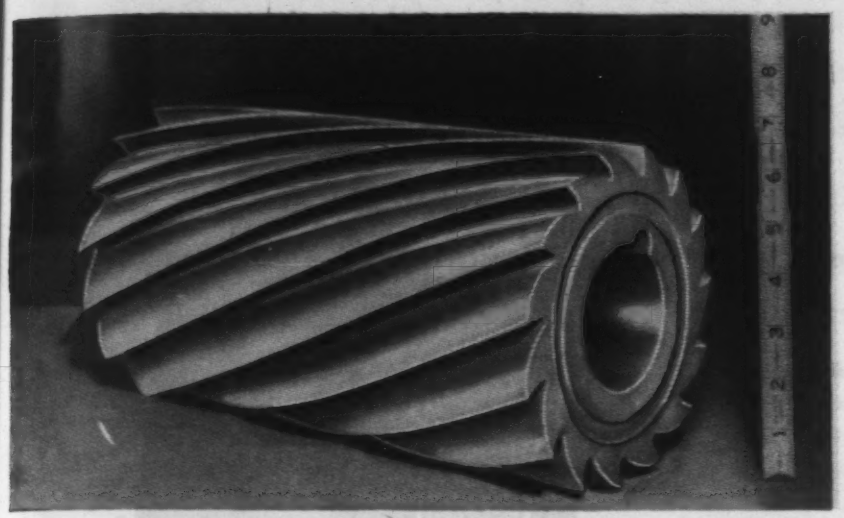


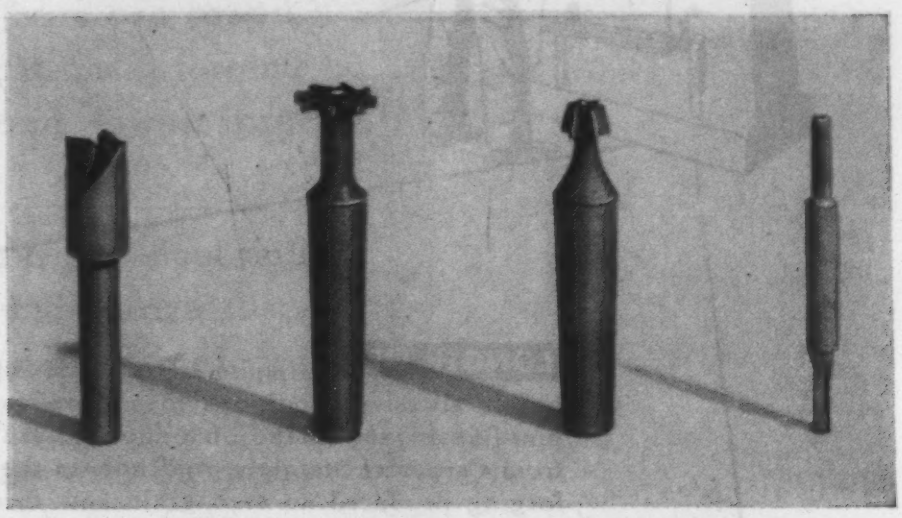
2. When the two furnaces are installed in accordance with this recommended layout, the operator, by making an easy pivot, can transfer work from the preheat furnace to the high-heat furnace without unnecessary steps. A water-quench tank can be located in front of the preheat furnace; an oil-quench tank, in front of the high-heat furnace.



3. During the heat treatment of high-speed steel, a protective atmosphere, free of carbon dioxide and water vapor, must be introduced into the furnace to prevent oxidation and decarburization of the steel. Such an atmosphere is created by the processing of standard fuel gases and air in this specially constructed, 200-cfh, G-E drycolene producer.

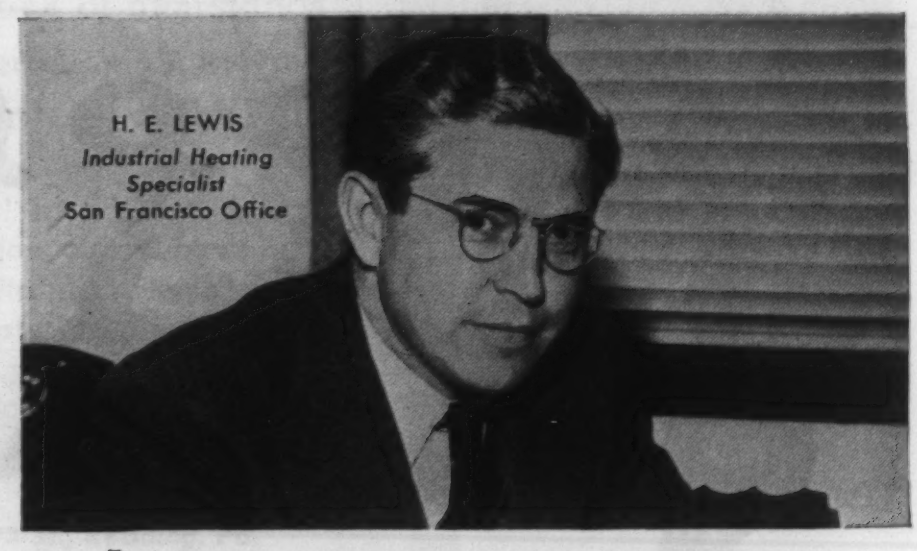


4. This sturdy, slab-milling cutter of Bethlehem No. 66 high-speed steel was made to size before heat-treating. It was given a first preheat at 550 F in air, a second at 1550 F in drycolene, and a high heat at 2250 F in drycolene plus propane. There was no decarb, and edges were file hard.



5. In cutters such as these, of moly and cobalt high-speed steels, both sharp cutting edges and sharp corners must be maintained. After heat treatment in a G-E Type TG box furnace, in drycolene atmosphere, the cutters were free of scale and decarb; both cutting edges and corners were file hard.

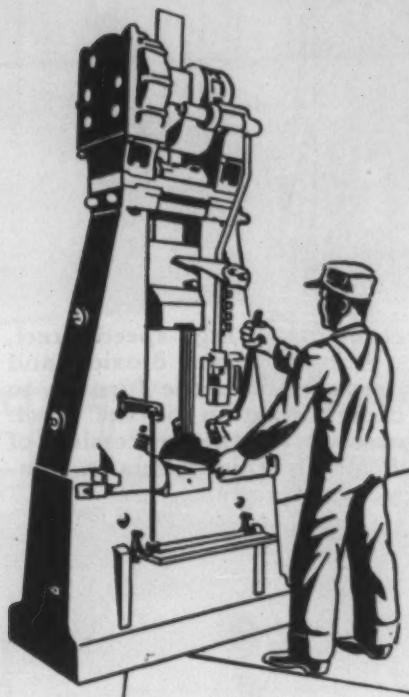
6. The cutting edge of the moly-cobalt, high-speed tool in this photomicrograph (X-500) clearly shows the absence of decarb and the uniform distribution of carbon particles. Because the hardness extends right to the surface, no finish-grinding is necessary.



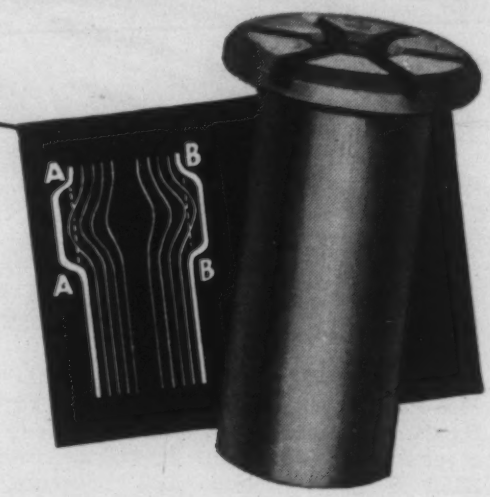
7. To advise you on an industrial heating problem, G.E. maintains heating specialists in all principal cities, plus an engineering staff qualified to recommend the *best* type of equipment for your particular purpose. For detailed recommendations, consult your nearest G-E heating specialist, or write Apparatus Dept., General Electric Company, Schenectady, N. Y.

GENERAL ELECTRIC

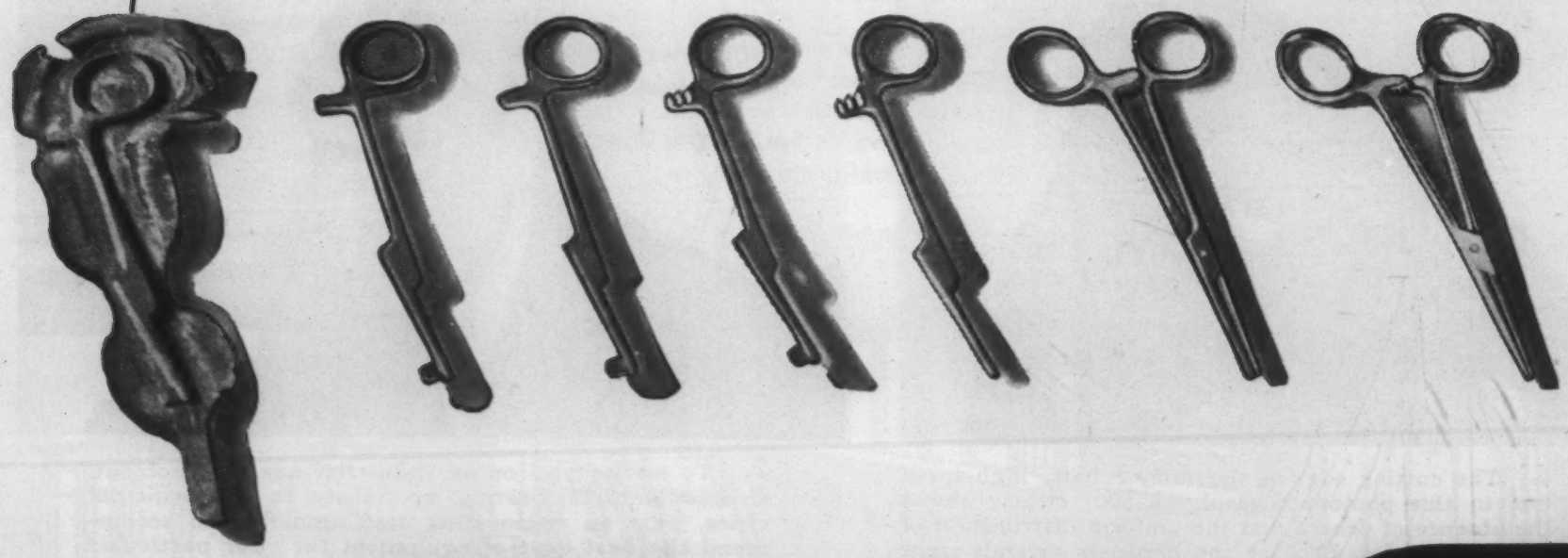
YOU GET CORROSION RESISTANCE PLUS



LOWER UNIT COSTS. This aircraft fuel supply valve body was forged from Carpenter *Stainless No. 8* (*Type 303*) forging bars. Our *machine-turned* billets, from which all Carpenter forging bars are rolled, provided freedom from injurious surface defects, reducing rejects to a minimum. The corrosion resistant properties of Stainless No. 8 licked the danger of "valve sticking" from high octane gas.



LONGER LIFE. In spite of tremendous pressures and highly abrasive conditions in service—forged knuckle pins like this stay on the job longer because they are made from Carpenter Stainless. And note in the diagram that forging produced an even grain flow throughout, thus strengthening the thin sections at points AA and BB.



POSITIVE PROTECTION against corrosion to withstand the effects of repeated sterilization plus the required strength and hardness, made Stainless a natural choice for these forged surgical instruments. Clean, flawless Carpenter Stainless forging bars reduced rejects, increased output.

more than corrosion resistance

ECONOMICAL, TROUBLE-FREE FORGINGS WITH *Carpenter* STAINLESS

If rejects run high when forging Stainless, it's time to check all along the line. Many factors must be controlled right in the forge shop. But to eliminate trouble and secure best results you must be sure that your forging bars are sound, clean and free from injurious surface defects. Such forging bars assure easiest forging operations and lowest production costs.

At Carpenter, Stainless Steels are made in a tool steel mill to tool steel quality standards. Stainless billets are disc-inspected to assure soundness and homogeneity—and are then *machine-turned* to remove all surface imperfections. By this painstaking process we end up with Stainless bars that, lot after lot, assure economical, trouble-free forgings.

You'll find your nearby Carpenter representative extremely helpful when it comes to finding ways and means of applying Stainless to your postwar products. Back of him stands a company with years of practical experience in solving Stainless problems. Call him in today or write us at the mill.

PUT THIS BOOK TO WORK! In addition to specific Stainless forging information, our 98-page book "Working Data for Carpenter Stainless Steels" shows you how to select and fabricate a wide variety of Stainless Steels. Be sure to get your copy! A note on your company letterhead, indicating your title is all that's necessary. Write today!

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- **No Plating to Peel**
- **Ease of Assembly**
- **Longer Product Life**
- **Sales Appeal**

Carpenter STAINLESS STEELS

BRANCHES AT Chicago, Cincinnati, Cleveland, Detroit, Hartford, Indianapolis, New York, Philadelphia, Providence, St. Louis

How Sound Metal Structure

● A design engineer who would avoid the pitfalls of misapplication that often penalize development work will derive from this case history, of a permanent-mold-casting, the basic reason for seeking and inviting the cooperation of a permanent-mold-casting engineer or metallurgist, or both, while the part is still in the design stage. Here is evidence that substantiates the claim that utmost care should be exercised in the selection of a permanent-mold-casting source or foundry.

One responsibility of a permanent-mold-casting source is to acquaint design engineers with the problems of mold designers and foundrymen and to guide them in incorporating features in the design of parts which will facilitate the permanent-mold-casting process and result in sound metal structure throughout the casting. *Such a procedure avoids costly, time-consuming cut-and-dry methods.* Do not allow common sand foundry experience or lack of knowledge regarding the development of permanent-mold-casting designs to impose needless restrictions on quality or mass production of parts or the proper use of permanent-mold-casting processes. Lowest piece price for each part at the point of assembly is usually the result of: (1) Developing and utilizing a permanent-mold-casting technique that achieves the lowest mold cost consistent with the high rate of mass production; (2) Taking advantage of the savings available by the use of metals from re-melt sources; (3) Sound casting quality and minimum scrap loss in machining and finishing; (4) Dependable delivery to meet assembly line schedules.

Different permanent-mold-casting techniques result in tangible and measurable differences in the quality of castings. To obtain the utmost of every advantage available in permanent-mold-castings, select the source that is fortified by scientific knowledge and broad experience concerning the physical and mechanical properties of available aluminum alloys, whether from virgin or re-melt sources, and the behavior of these alloys in fabricating parts. The vital element in obtaining sound casting quality is skill and experience in utilizing the correct alloy and employing the correct permanent-mold-casting technique.

A Permold Engineer or Metallurgist, backed by 27 years of engineering and metallurgical experience and by 24 years of foundry experience, can help you avoid unnecessary experimentation and assist you in obtaining a permanent-mold-casting of sound metal structure throughout. Ask a Permold Engineer for a copy of technical booklet which tells how to utilize to the utmost the excellent physical properties and heat treatment potentialities of aluminum alloys.

perMold

THE PERMOLD COMPANY

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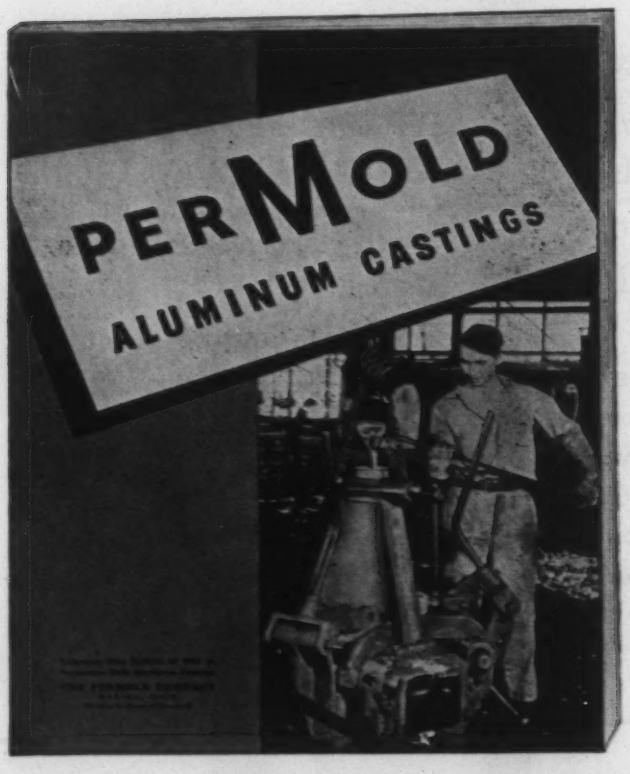
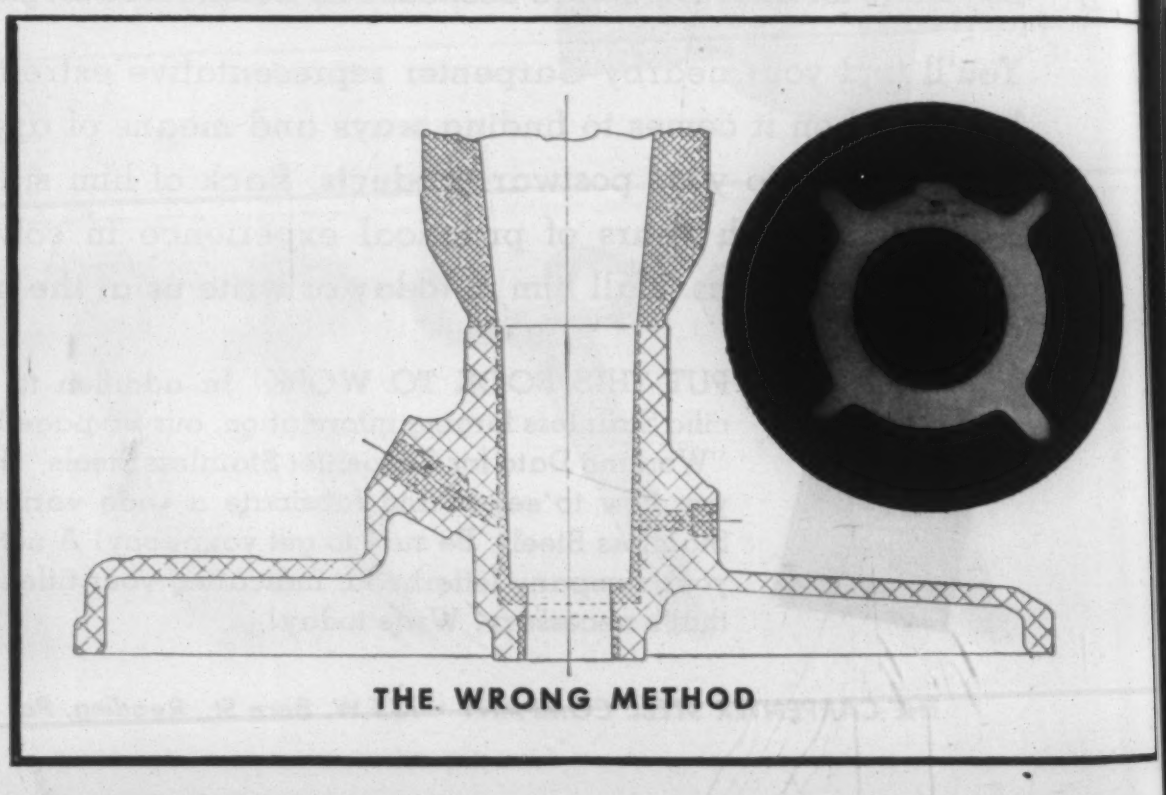




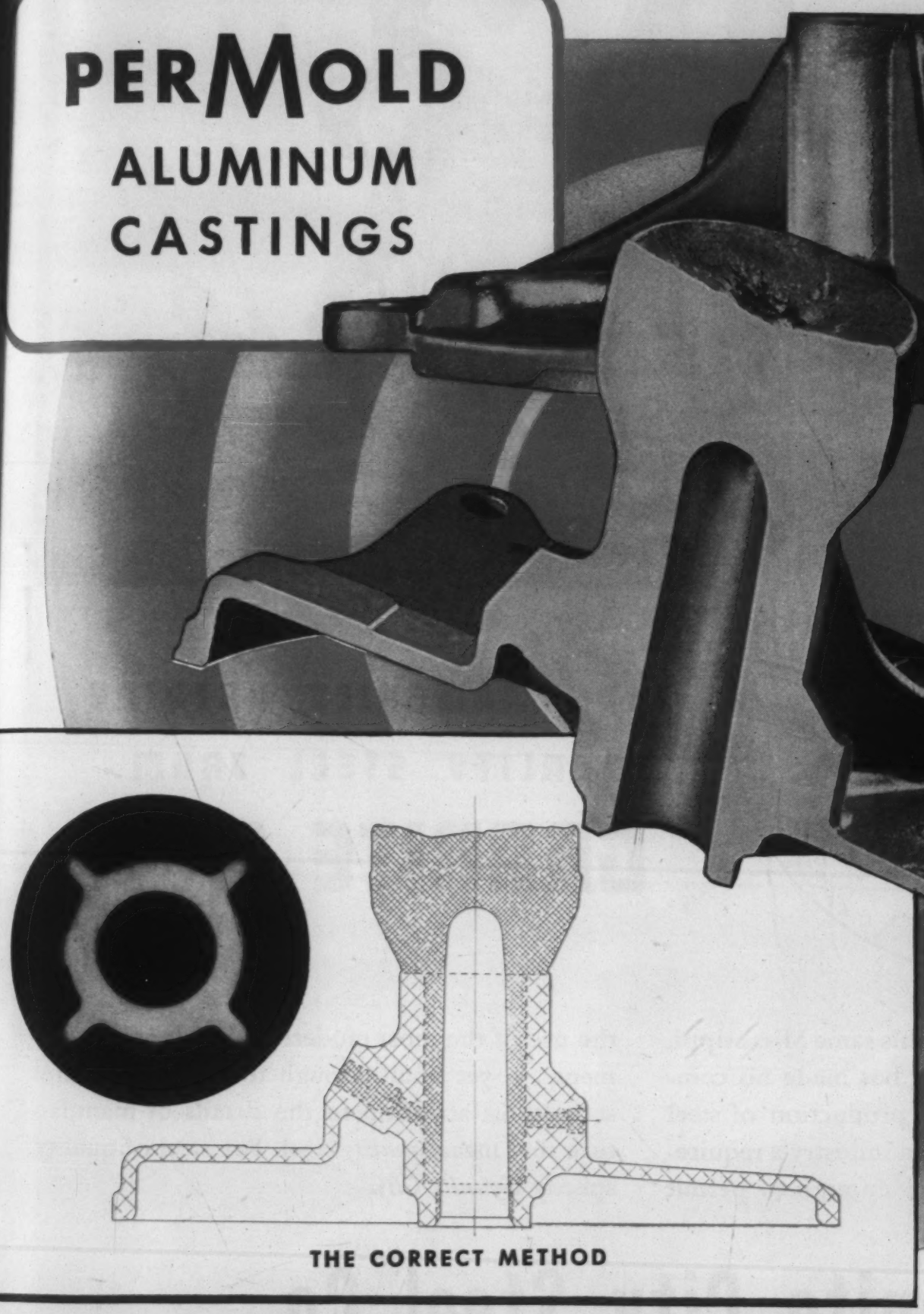
THE WRONG METHOD

Write for copy of Technical Reference Booklet PMC 45, which presents practical suggestions for designing parts for aluminum permanent-mold-casting techniques and a brief treatise on aluminum alloys that are suitable for permanent-mold-casting. This booklet has been prepared especially for the guidance of design engineers, metallurgists, production and management executives, who must determine when, where, and how to employ permanent-mold-castings, and to obtain lowest piece price for each part at the point of assembly.

This casting is part of an assembly containing liquid under pressure and must be leak proof. This part was originally produced as a die casting, but castings made by this process were found to be unsatisfactory because of high scrap loss due to leakage at point of assembly. When it was decided to have the part made as a permanent mold casting, it was recommended by Permold Engineers and Metallurgists that in order to obtain sound structure throughout the casting it should be made as shown in detail of "Correct Method." This involved a considerable amount of metal to be removed by subsequent machining operations, which was objected to by the production engineers, and against PERMOLD recommendations the initial permanent mold for casting this part was constructed as shown in the detail of "Wrong Method." When castings got into the production line and were fully machined and brought to the point of final assembly, pressure tests showed a high percentage of leakage. This leakage was unavoidable because the design made it impossible to feed heavy sections of the part properly, resulting in shrinkage, which was verified by X-rays at the point where leakage occurred.

is obtained in Permanent Mold Castings

PERMOLD
ALUMINUM
CASTINGS



THE CORRECT METHOD

Having definite proof that sound leak-proof structure could not be obtained with the design as shown in the detail of "Wrong Method," the customer then authorized the design which permitted the permanent mold to be built as shown in the detail of the "Correct Method" as was originally suggested by PERMOLD Engineers and Metallurgists. The production castings made from this mold were subjected to pressure tests, which established the fact that leakage had been overcome. X-rays were made of the same sections of these castings, substantiating the fact that porosity had been entirely eliminated and sound structure obtained. The design of this casting is such that there are fairly heavy sections adjacent to the main flange of the casting. When the metal in these sections solidifies the sections shrink internally due to crystalline shrinkage, and this shrinkage will result in voids if the metal is not fed from an outside reservoir of molten metal. The design insisted on by the production engineers in their commendable desire to keep machining to a minimum resulted in choking off the feed of molten metal from the outside reservoir at the top of the neck of the casting, due to this section being much smaller than the heavy sections lower down. The design recommended by PERMOLD Engineers and Metallurgists is such that the outside reservoir of molten metal functions fully to feed this shrinkage, thereby assuring sound structure throughout the casting.

A Permold Engineering and Metallurgical Review brings you:

1. Sound Engineering Experience (24 years) in utilizing aluminum alloys, and in developing permanent-mold-casting techniques, to meet a wide range of service requirements.

2. Design suggestions, resulting from hundreds of applications of permanent-mold-castings, to guide you in obtaining unusual savings available through the use of high strength aluminum alloys and lighter weight sections.

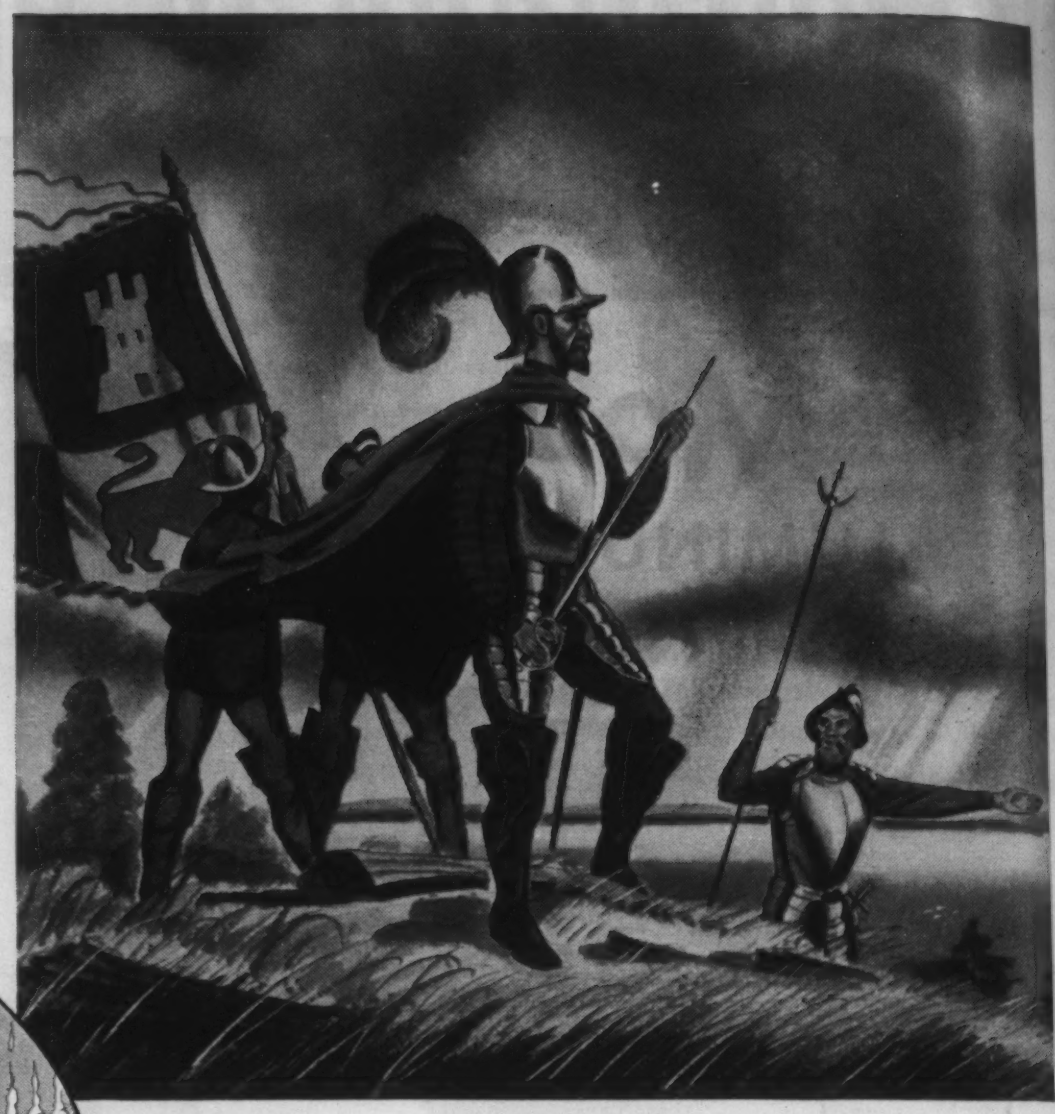
3. Recommendations covering correct combinations of physical properties required to meet given service conditions; and how to utilize the excellent physical properties and heat treatment potentialities of aluminum alloys to protect your product against failure.

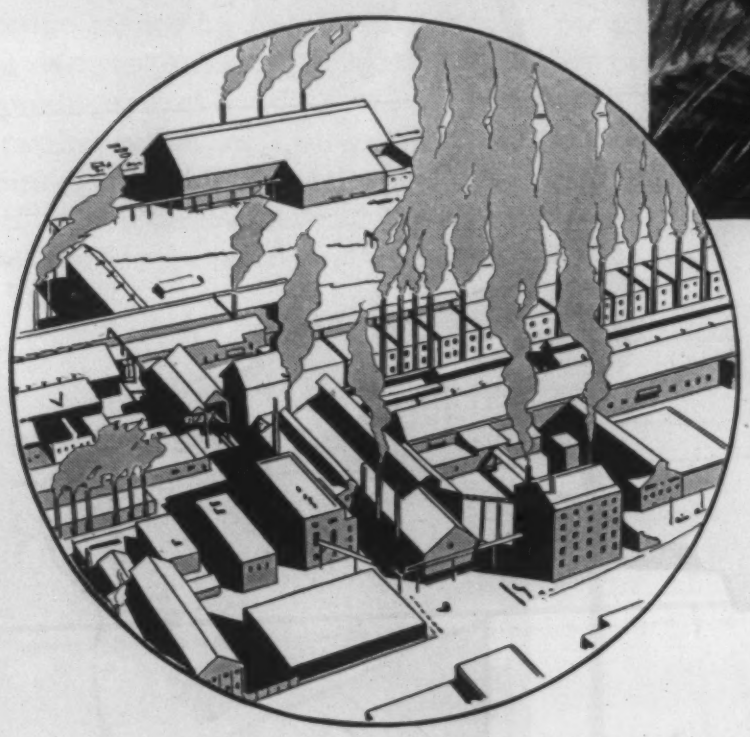
4. Estimates of cost-reducing possibilities which may be realized through the use of permanent-mold-castings and metal from re-melt sources.

5. Technical facts resulting from comparisons of materials, processes, and costs usually overlooked and unappreciated except by those of broad specialized experience in the highly skilled art of permanent-mold-casting on a mass production basis.

STEEL OF QUALITY FROM TOLEDO PIONEERED A NEW WORLD

In 1539, a small band of Spanish explorers beat their way westward through an unexplored wilderness. Their progress and their very lives depended upon the quality steel of their weapons . . . steel from the forges of Toledo, known for centuries as the finest. Two years later, in 1541, their leader, Fernando De Soto, became the first white man to look upon the waters of the Mississippi. Quality steel had carried them to the center of a great new world.





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Since 1878, on the banks of this same Mississippi, Granite City Steel Company has made no compromise with quality in the production of steel tailor-made to meet American industry's requirements. Its facilities are large enough to permit the use of the most modern methods and equipment . . . yet small enough to permit the most scrupulous attention to the details of manufacture that mean *quality* steel. For steel of quality, specify *Granite City.*

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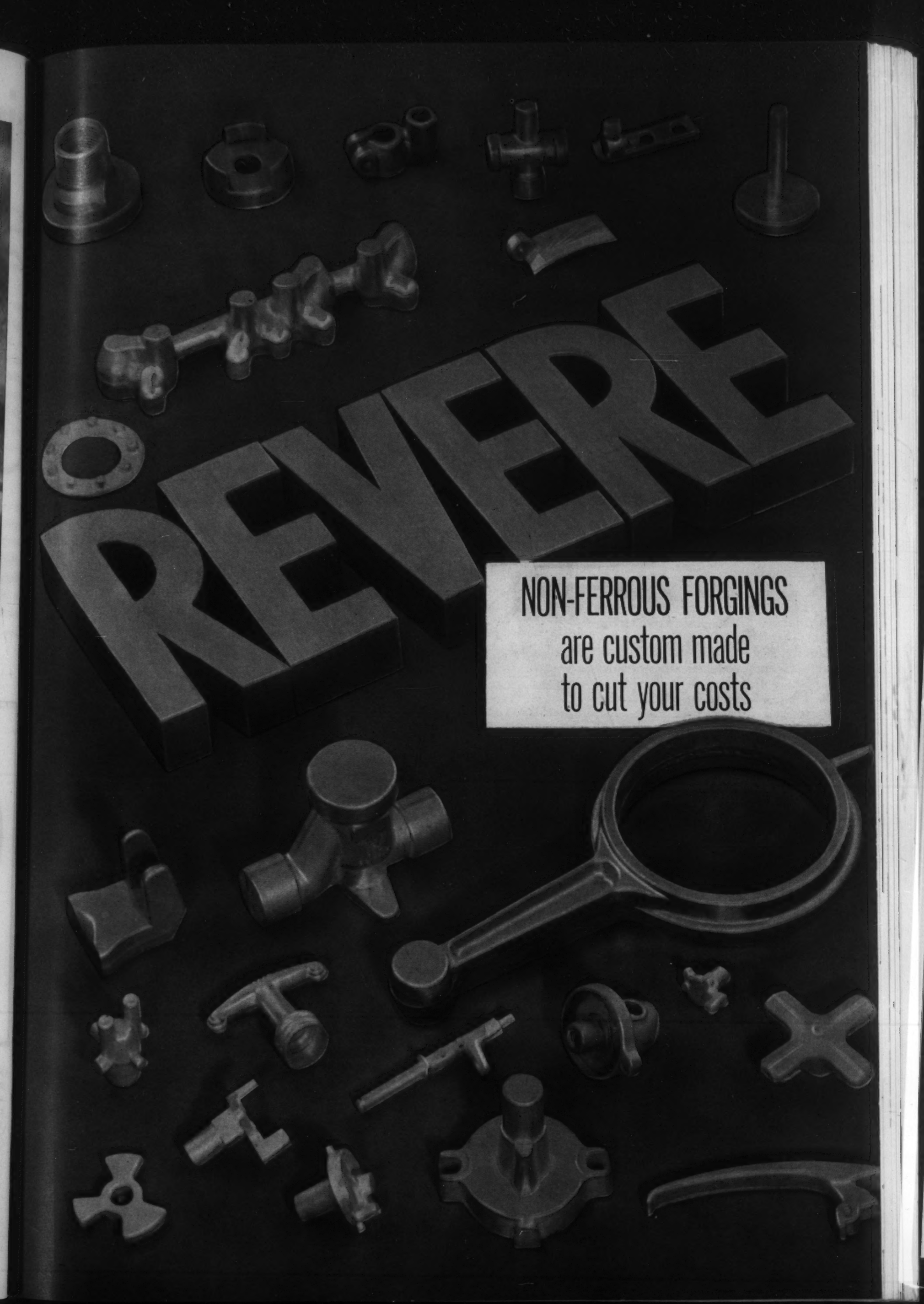
REVERE
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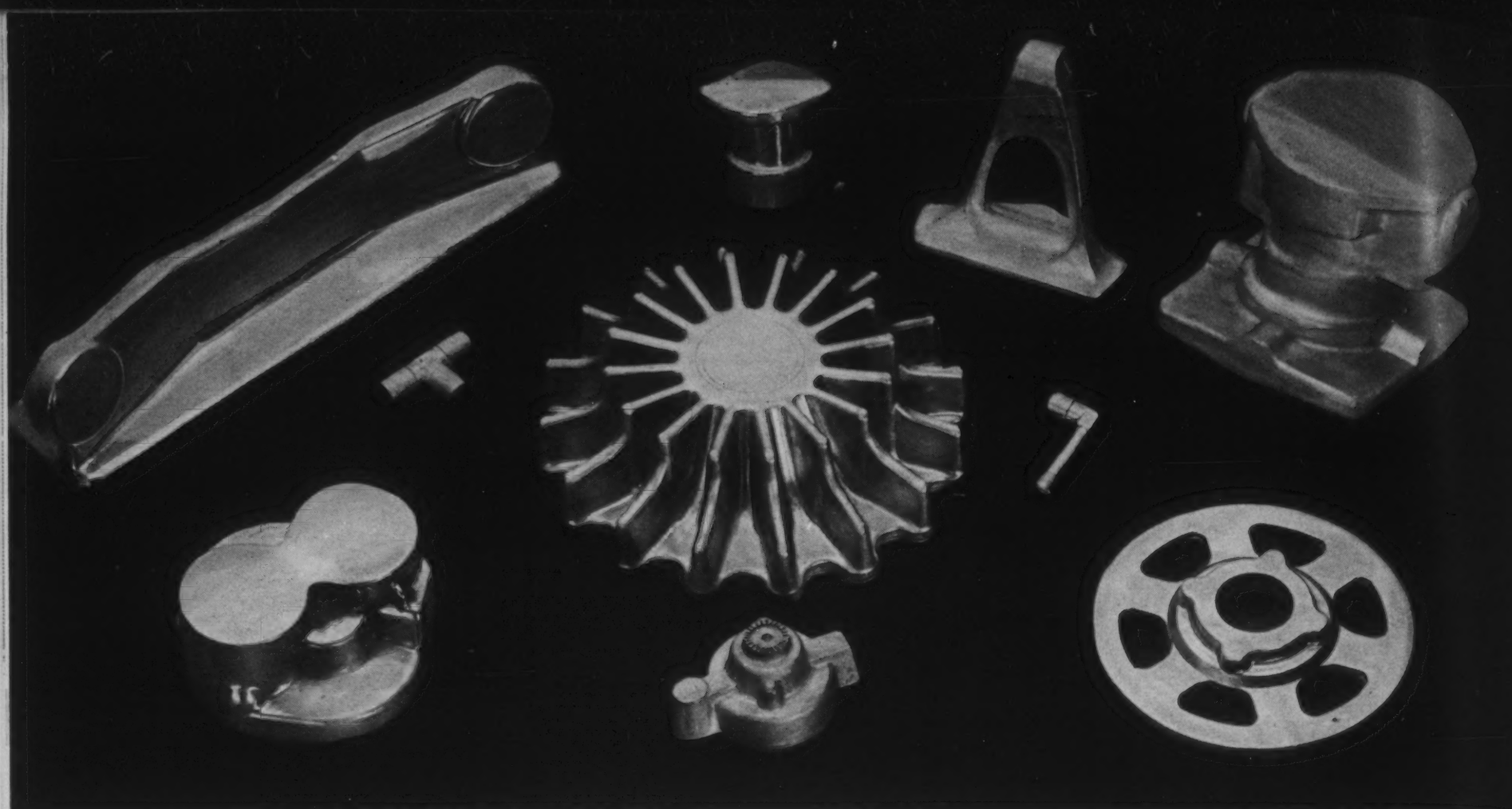
are custom made
to cut your costs



PRODUCT IMPROVEMENT PLUS PRODUCTION ECONOMY

REVERE Non-Ferrous Forgings can both improve your product, and cut your manufacturing costs. Product improvement is due to the fact that these forgings have increased strength-weight ratios, and hence weight reduction may be possible. Complicated parts previously built up of several pieces may be produced in a single piece, for greater strength, better appearance, and less cost. Revere Forgings are accurate in dimensions, so that machining is reduced considerably, and along with it, machine time, scrap and rejects. Thus these forgings can solve many production problems, open bottlenecks, and in addition reduce your costs.

Increased Strength

In non-ferrous die-pressed forging, the heated metal is placed between dies, and tremendous pressure forces the metal into the desired form. This produces a fine, close grain structure, greatly increasing tensile strength.

"Twice Wrought"

Revere Forgings are forged from Revere Extruded material. Thus the metal has attained the greatest possible density through being worked twice under the tremendous pressures employed in each operation. The result is the highest tensile strength, toughness and fatigue resistance possibly obtainable in the metal or alloy. A few alloys are heat-treatable if desired.

Better Appearance

Surfaces are good. Small design details such as trade-marks, model numbers and names can be held sharp and true.

Non-Porous

Being uniform in density and without blow-holes or similar defects, Revere Forgings are impervious to oils, other liquids, and gases. Hence they are widely used in chemical plants, oil lines, refrigeration and other gas apparatus.

Speedy Machining

The denseness and uniformity of the metal makes possible higher machining speeds. The complete absence of sand inclusions makes tools give longer runs before re-grinding.

Plating

Any of the following finishes may be applied to Revere Copper and Copper Alloy Forgings with excellent results: Pickling, Bright Dip, Satin Dip, Bright Polish, Lead Dip, Cadmium Plate, Nickel Plate, Copper Plate, Chromium Plate, Silver Plate, Gold Plate. For high-quality plating it is necessary to give the surface a preliminary polish, but the cost of this is low because of the relatively smooth surface of the forging. Plating is possible on aluminum and magnesium but pickling or anodizing of these alloys usually is preferable and sufficient.

Dimensions

Maximum and minimum dimensions and tolerances depend on the alloy and the design of the part. Revere can now produce larger forgings than ever before, up to 30″ in the largest dimension in some cases.

Long Experience

Revere was a pioneer in die-pressing hot non-ferrous metals into high-quality forgings. Since 1922 we have been developing machines and methods for that purpose, and today the Revere forging techniques produce exceptional results. Another important Revere asset is the fact that we have had 145 years of experience with metals. Most of the alloys Revere forges are produced in Revere's own plant, under close laboratory control, and the forgings themselves are constantly inspected for size, strength and uniformity.

Custom-Made

Every Revere Forging necessarily is custom-made to your design. Revere Technical Advisors work closely with you to obtain the information needed by our die-makers, and to see you obtain the full benefits of the forging process.

Quantities

Large orders are not necessary. Dies for small lots may be made as cheaply in many cases as patterns for castings, and naturally subsequent orders still further reduce the cost.

Write Revere. Just say, "Send someone to see me about forgings."

REVERE PRODUCES
NON-FERROUS FORGINGS IN:

COPPER • REGULAR BRASS
NAVAL BRASS • BRONZE
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For: Plumbing Goods, Hardware, Pressure Fittings, Valves, Engine Parts, Electrical Equipment, Automotive Parts, Welding Nozzles, Contacts, Wing Nuts, Anchor Bolts, Bushings, Refrigeration Equipment, Pump Parts, Housings, in general, Highly Stressed Parts.

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Intensive research again enables the Alloy Rods Company to lead the field by reducing the number of basic stainless coating types to **two.** Compare these newly-improved coatings with competitive rods. You'll agree that they do any job in your shop **better.**

ARCALOY LIME COATING

- All position DC welding
- Easily controlled penetration on light gauge sheets
- Highest quality physical and corrosion resisting properties
- Sound metal and perfect color match with parent metal
- Weld contour minimizes grinding and polishing time

Available in all chemical analyses for DC welding. Designed for maximum welding ease in flat, vertical and overhead positions. Qualified to meet every individual company or government agency specification. Manufactured under rigid control methods by the extrusion process. Each core wire is concentric with the coating and firmly bonded. Identified by a **green** coating.

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- Quality welding with either AC or DC current
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- Excellent slag removal and negligible spatter
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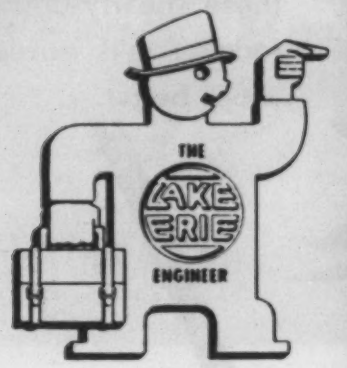
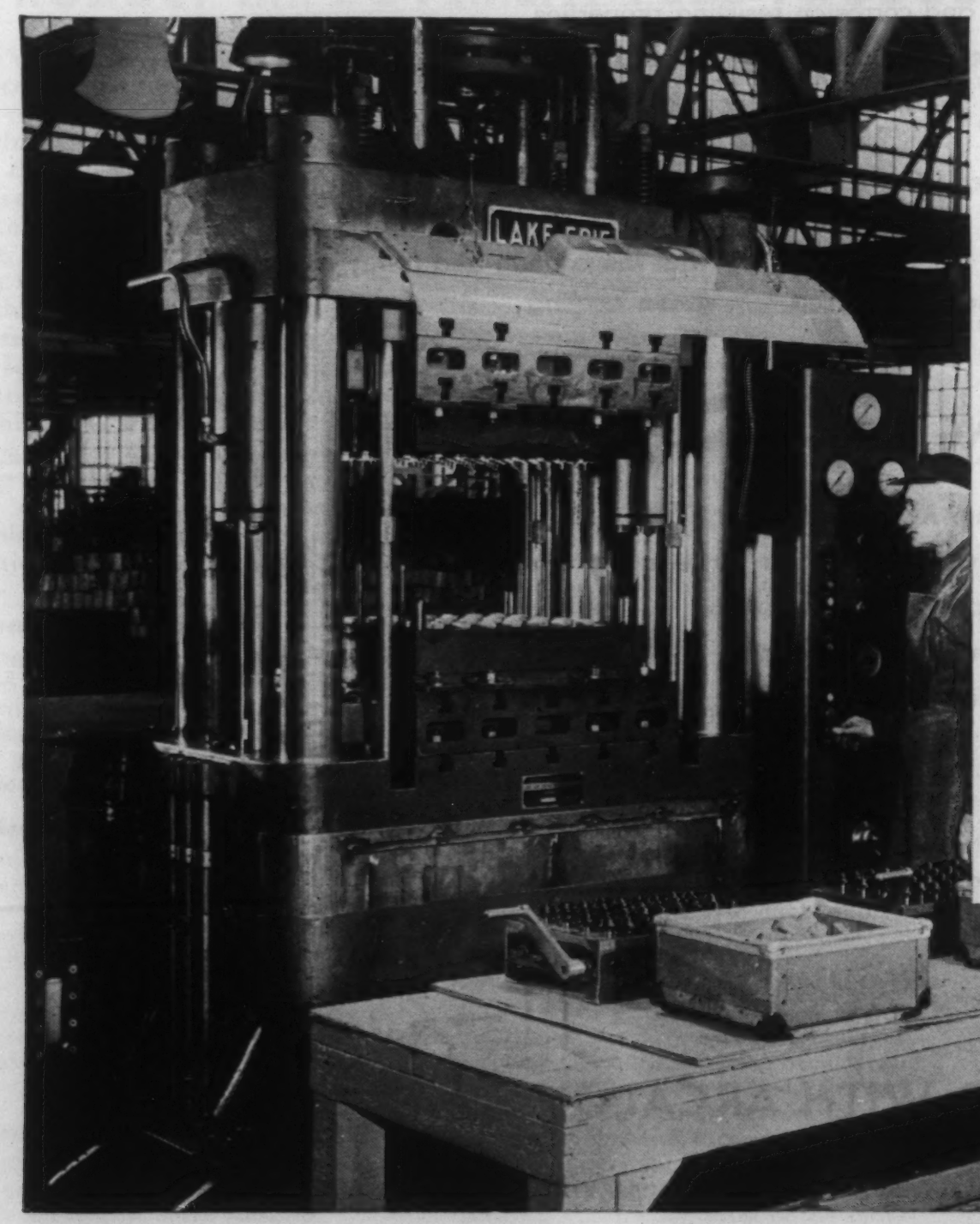
DO IT BETTER WITH ARCALOY

Alloy Rods Co.
York, Pa.

How the Ford Motor Company

Rotors are turned out at the rate of more than 150 per hour on this 300-ton automatic Lake Erie Hydraulic Press at the Rouge Plant.





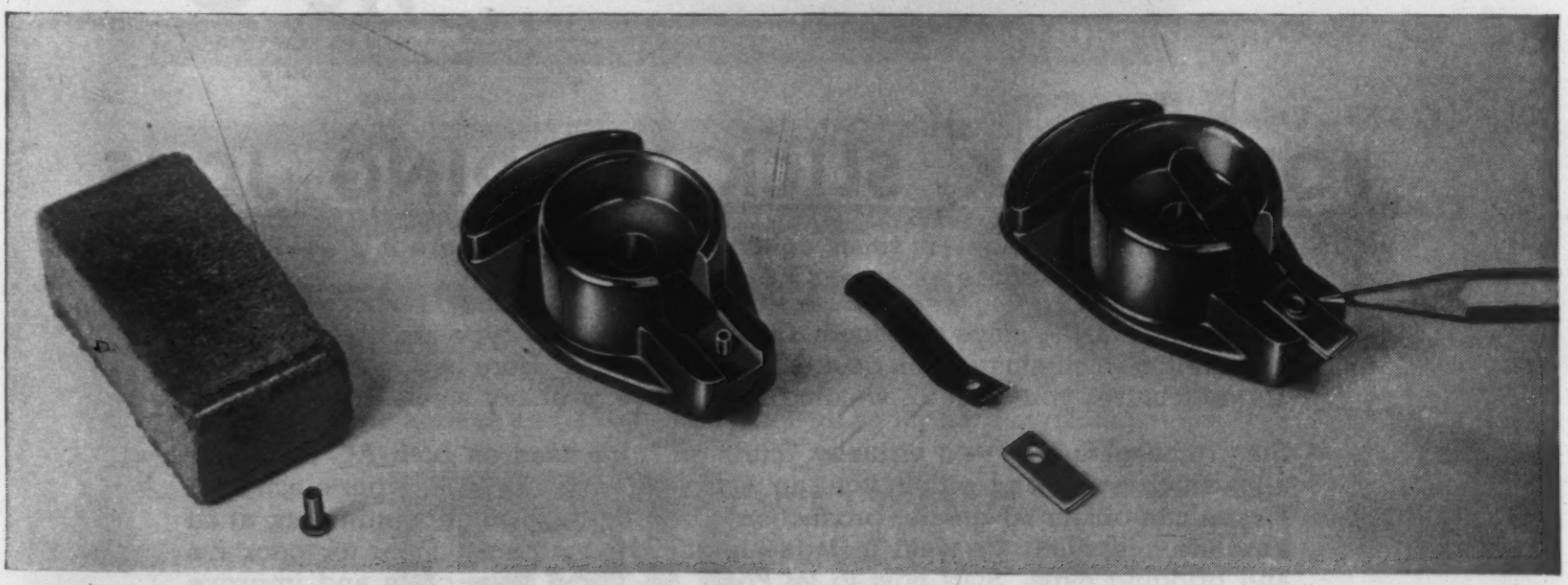
1 Preforms of thermosetting plastic material are placed in the 35-cavity mold. A rivet has already been inserted in each cavity and will become an integral part of the rotor. The preforms are seasoned for 24 hours at 110° F. in a room with strictly controlled humidity, and are preheated for 3 minutes at 180° F. in an infra red oven before being placed in the press. The wide opening between the platens of the Lake Erie press permits easy access to the entire working area of the mold.

2 A push of the button and the fully automatic molding cycle is underway. The bottom platen rises quickly to the closed position, slowing its speed as soon as contact is established with the upper platen. While the press is closed, heat and pressure complete the molding. An adjustable timer governs the time the press is closed, while the temperature of the electrically heated platens is thermostatically controlled within a four degree limit.

produces Distributor Rotors...

3 When the molding cycle is completed—the press is closed for 5 minutes at 300° F.—the Lake Erie Press automatically opens to its full width. The operator then removes the molded rotors and flash or excess material. Within 2 minutes after the molded rotors are removed from the Lake Erie press, they are placed in the ingenious cooling fixture shown in 4.

4 The rods on which the rotors are being mounted are exact duplicates of the rods on which the rotors will be assembled in the distributor. In cooling to room temperature, the rotors shrink onto the rods and are held to within 2/10,000 of an inch of the exact fit required for installation in the Ford engine. A turn of the crank strips the cooled rotors from the rods.



Various stages in the manufacture of Ford rotors. At the left is the preform of thermosetting plastic material and the rivet which is integrally molded in the rotor. Next is the molded rotor with steel spring and brass tongue ready for assembly. At the right is the completed rotor. The pencil gives an idea of the small size of the parts and the need for precision presses and molds in manufacturing this vital Ford part.

● *Lake Erie Hydraulic Molding Presses, Laboratory and Test Presses are fully illustrated and described in Bulletin 544 just off the press. Write for a copy of this latest information today.*

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AC-3 welds fast . . . lays in smooth, flat beads. Its spray-type arc gives medium penetration — eliminates thin gauge "blow-throughs." Here in one electrode are all the features you want for welding light gauge or heavy steels.

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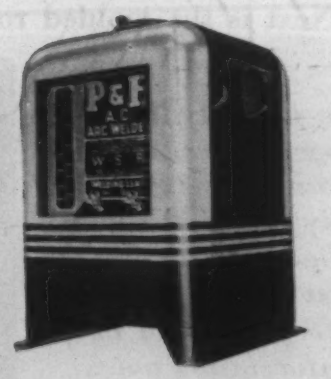
In addition to a line of simplified DC welders, P&H's AC welders range up to 1250 amperes. Each is equipped with creep-proof, micromatic control: WSR (Welding Service Range) ratings specifying the exact amount of *usable* welding current from minimum to maximum. Shown here is the model TWH 500 with a service range of 100 to 625 amperes.



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There's a production-proved P&H mild steel electrode for every requirement. This partial list shows many that are popular with foremost industries doing large scale-production welding. Get complete information.

SEE YOUR P&H REPRESENTATIVE

"AP"	— AWS — E-6010
"AC-1"	— AWS — E-6011
"PF"	— AWS — E-6012
"AC-3"	— AWS — E-6013
"FW"	— AWS — E-6020
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"CM-50"	— AWS — E-7011
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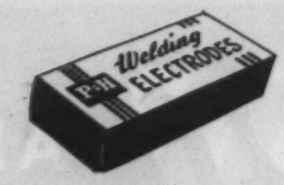
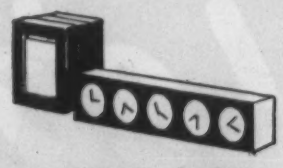


Welding Electrodes

Welding Positioners



Welding Production Control Systems

Electric Hoists

How Lebanon

Ⓛ 19... Ⓛ 22... Ⓛ 205

Meet LOW TEMPERATURE

Service Requirements

IN selecting casting alloys for low temperature service, it is especially important that information about physical properties be reliable. The charts shown are based on information gained during Lebanon's long experience in producing castings for service at temperatures ranging from 32° F. to −300° F. ... and upon Lebanon's extensive investigations in the field of low temperature operations.

Lebanon produces two types of casting materials for use at low temperatures: ferritic steels for service to −150° F. (Circle Ⓛ 19 and Circle Ⓛ 205); austenitic steel for service below −150° F. (Circle Ⓛ 22). Accurate information on the impact properties of these three steels is presented on the charts opposite. All data is influenced by variables in design, section variations and gradients.

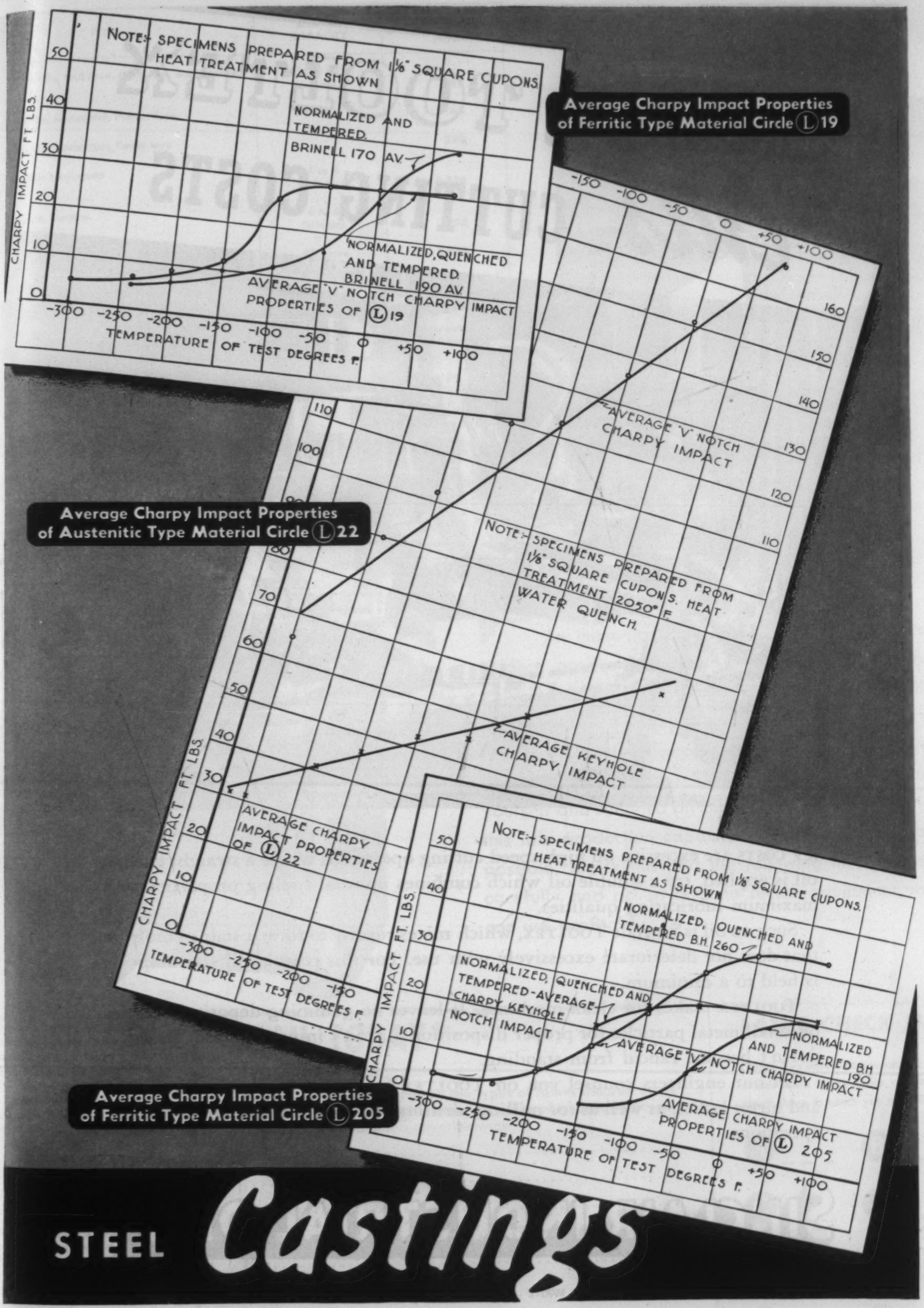
Lebanon is prepared now to cooperate with you in design and materials selection for castings for low temperature operation. Write stating your service conditions.

LEBANON STEEL FOUNDRY • LEBANON, PA.

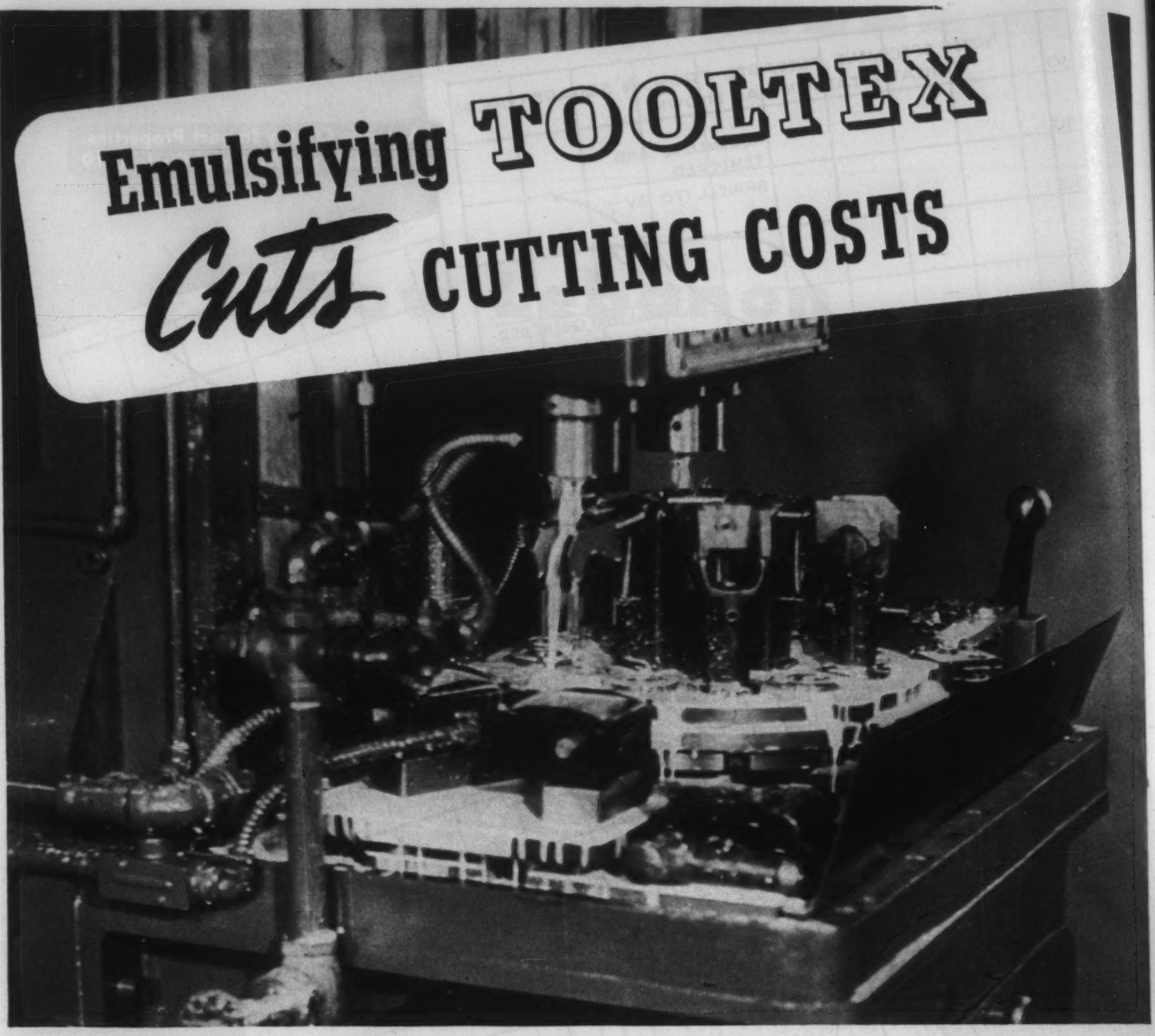
ORIGINAL AMERICAN LICENSEE GEORGE FISCHER (SWISS CHAMOTTE) METHOD

"In the Lebanon Valley"

Lebanon ALLOY AND


Average Charpy Impact Properties of Ferritic Type Material Circle (L) 19
NOTE:- SPECIMENS PREPARED FROM 1⅛" SQUARE CUPONS. HEAT TREATMENT AS SHOWN
NORMALIZED AND TEMPERED. BRINELL 170 AV.
NORMALIZED, QUENCHED AND TEMPERED. BRINELL 190 AV.
AVERAGE "V" NOTCH CHARPY IMPACT PROPERTIES OF (L) 19
CHARPY IMPACT FT LBS
TEMPERATURE OF TEST DEGREES F.
Average Charpy Impact Properties of Austenitic Type Material Circle (L) 22
AVERAGE "V" NOTCH CHARPY IMPACT
AVERAGE KEYHOLE CHARPY IMPACT
NOTE:- SPECIMENS PREPARED FROM 1⅛" SQUARE CUPONS. HEAT TREATMENT 2050° F. WATER QUENCH.
AVERAGE CHARPY IMPACT PROPERTIES OF (L) 22
Average Charpy Impact Properties of Ferritic Type Material Circle (L) 205
NOTE:- SPECIMENS PREPARED FROM 1⅛" SQUARE CUPONS. HEAT TREATMENT AS SHOWN
NORMALIZED, QUENCHED AND TEMPERED B.H. 260
NORMALIZED, QUENCHED AND TEMPERED-AVERAGE CHARPY KEYHOLE NOTCH IMPACT
AVERAGE "V" NOTCH CHARPY IMPACT
NORMALIZED AND TEMPERED B.H. 190
AVERAGE CHARPY IMPACT PROPERTIES OF (L) 205
STEEL Castings

Emulsifying TOOLTEX *Cuts* CUTTING COSTS



If costs are excessive on high speed cutting operations where a straight cutting oil is applied, try a soluble oil which combines unusual cooling properties with maximum lubricating qualities.

Such an oil is Sinclair Tooltex, which mixes readily to form a stable emulsion that does not deteriorate excessively with use. For this reason, oil consumption is held to a minimum.

Tooltex makes for clean machines. It leaves no gumming deposits...carries off small metal particles for proper disposition...won't injure operator's skin... doesn't become rancid from standing.

Let our engineers counsel you on Tooltex for use on hand screw machines and turret lathes, as well as for milling, drilling, planing and certain broaching operations.

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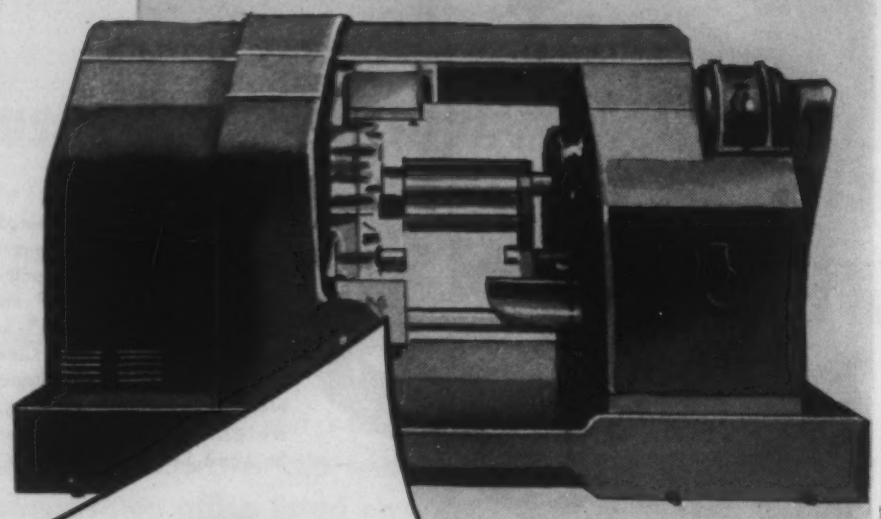
CIAL LATHE BUYS!

TYPE	SIZE OR CAPACITY	QUANTITY AVAILABLE NOW
Heavy Duty Mfg. and Prod. Multi-tool, not automatic	Up to 20" swing	788
Single Spindle, Horizontal, Platten type		63
Single Spindle, Horizontal, Turret type		280
Multi Spindle, Horizontal	4 to 8 Spindles	1,518
Multi Spindle, Vertical	6 to 8 Spindles	202
Auto. between centers chucking, horiz. single spindle	All sizes	2,036
Speed Lathes	1/6 to 5 HP	2,070
Turret Lathes	All sizes	144

(D) Multiple Spindle Horizontal Lathes

These 4, 5, 6 and 8 spindle machines or equivalent (see table) are located in Chicago, Cleveland, Detroit, Nashville and St. Louis offices of War Assets Administration. Ask any W. A. A. office.



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LATHES

An immediate source of additional or more modern production equipment is the large inventories held by the War Assets Administration. Built for war, basic machine tools such as these lathes are ready to serve in peace. Hundreds of items are available now, priced for quick sale. You can do yourself and America an important service by putting this idle production capacity to work as quickly as possible. Check this and the following three pages carefully and act at once to secure equipment you can use profitably.

(A) Heavy Duty Mfg. and Prod. Multi-tool Lathe (not automatic). These heavy duty production tools are available in quantity in Detroit, Chicago, Boston, and New Orleans offices of War Assets Administration. For details contact any W. A. A. office.

Veterans of World War II— To help you in purchasing surplus property, veterans' units have been established in each War Assets Administration Regional Office.

MAIL TODAY*

To War Assets Administration:

Please send me information on the types of lathes checked at the right. I am also interested in the availability of the following types of lathes not listed in this advertisement:

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**For War Assets Administration address, see 4th page of this advertisement.*

277-4

LATHE CHECK LIST

(These key letters correspond to the machines listed in the table above. Simply check those in which you are interested.)

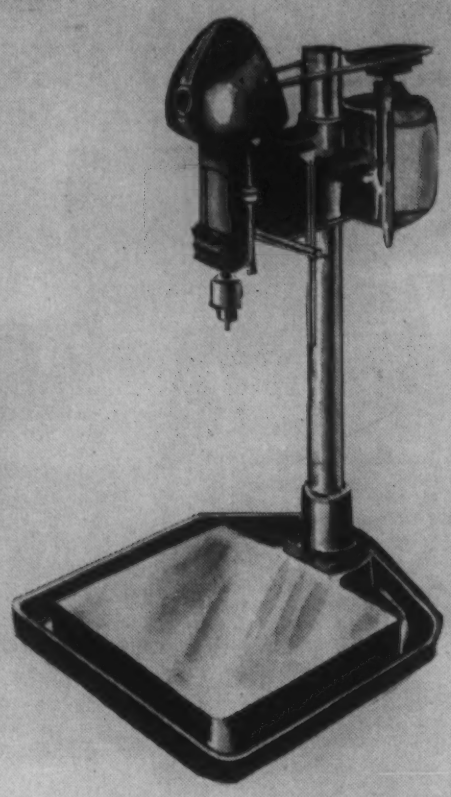
(A)___ (B)___

(C)___ (D)___

(E)___ (F)___

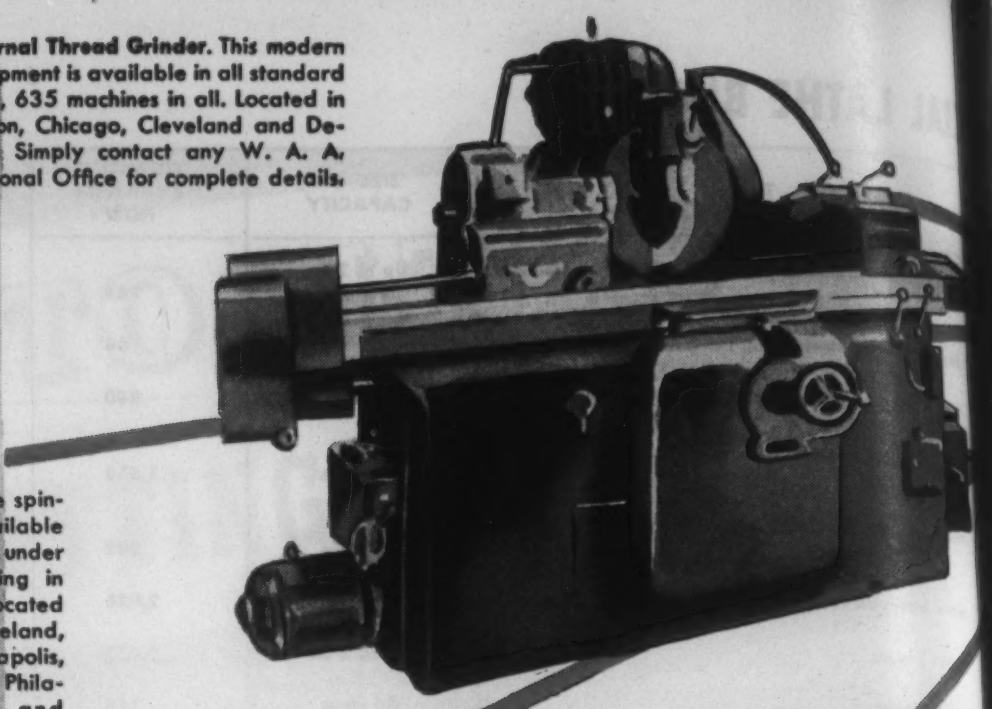
(G)___ (H)___

277-4

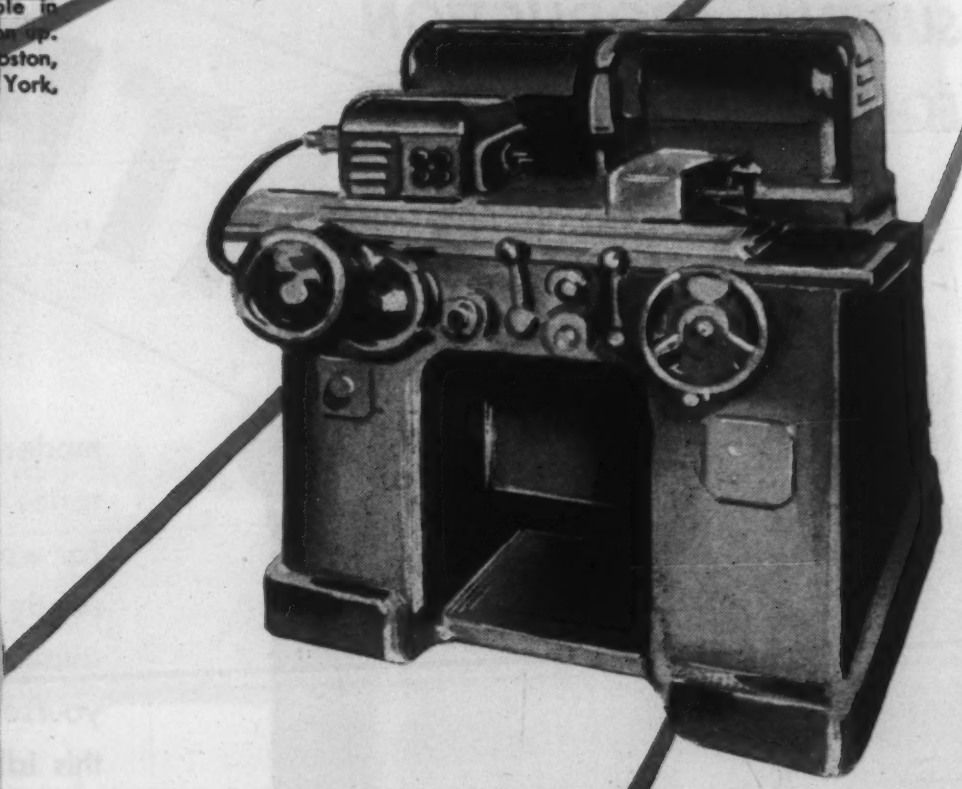


Bench Drill. Sensitive, single spindle, round column type; available up to 22" swing in capacity under ½"; from 16" to 24" swing in capacity from ½" to 1". Located in Boston, Birmingham, Cleveland, Charlotte, Detroit, Minneapolis, New York, Oklahoma City, Philadelphia, San Antonio and St. Louis Regional Offices.

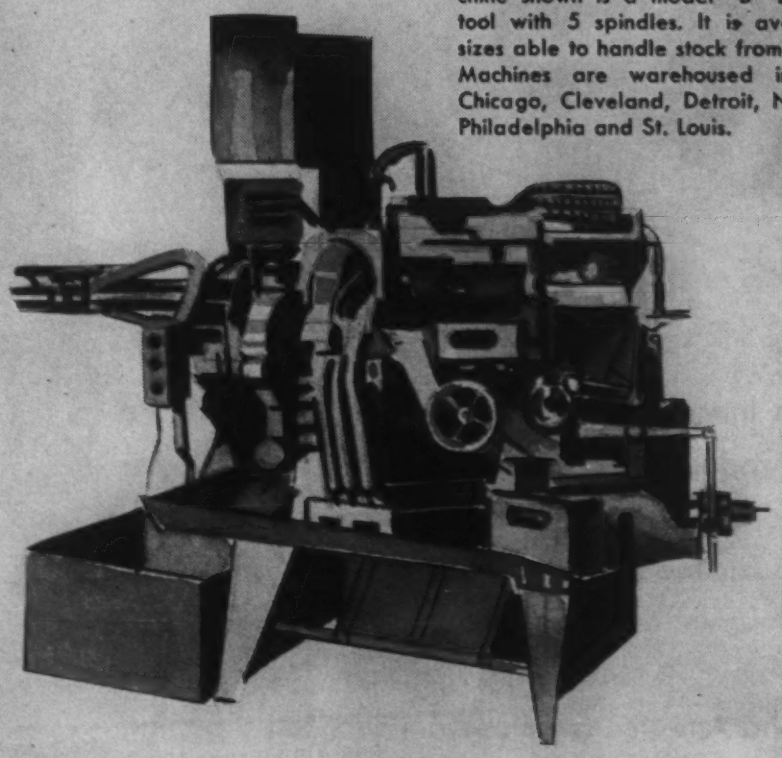
External Thread Grinder. This modern equipment is available in all standard sizes, 635 machines in all. Located in Boston, Chicago, Cleveland and Detroit. Simply contact any W. A. A. Regional Office for complete details.

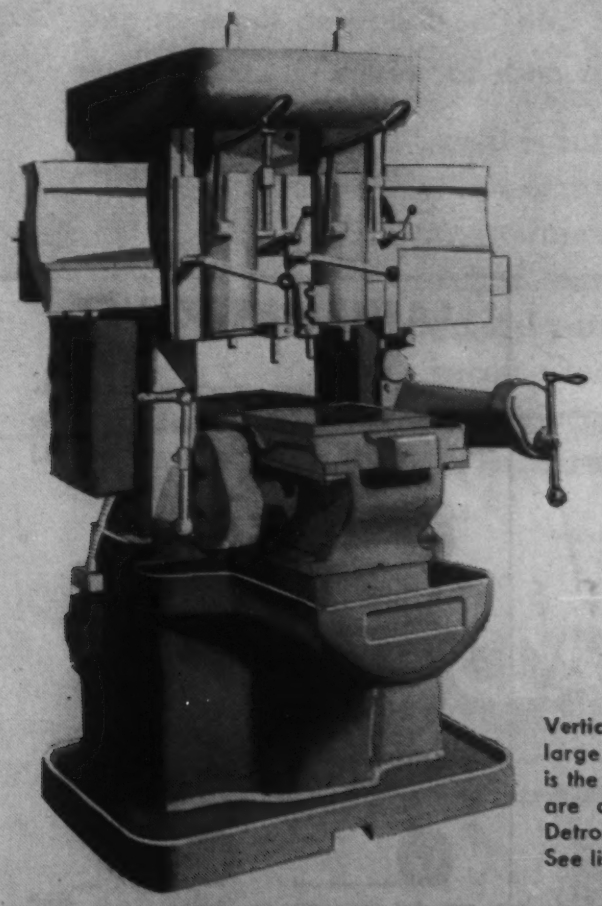


External Cylinder Grinder—Plain. This is a Norton model but other makes are also available. Total inventories in Boston, Chicago, Cleveland, Detroit, Philadelphia and St. Louis amount to 1730 machines.

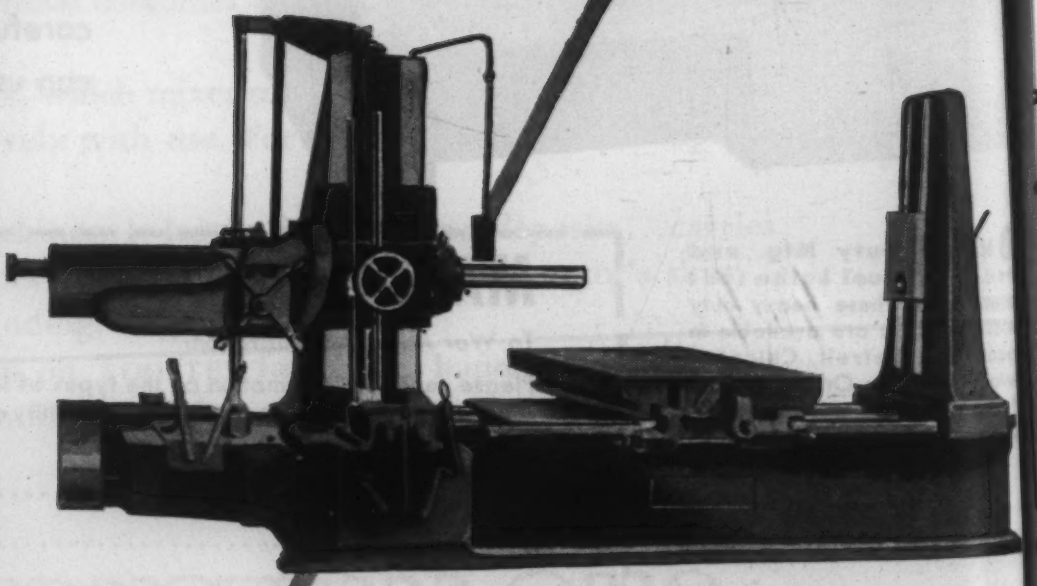


Automatic Screw Machine-Bar. The machine shown is a model "B" Davenport tool with 5 spindles. It is available in sizes able to handle stock from 1" on up. Machines are warehoused in Boston, Chicago, Cleveland, Detroit, New York, Philadelphia and St. Louis.





Vertical Profiler—2 spindle type. Typical of a large number of 1, 2, 3, and 4 spindle machines is the milling machine shown here. These machines are available in Boston, Chicago, Cleveland, Detroit, New York and other Regional Offices. See list (next page) for other types also in stock.



Horizontal Boring, Drilling and Milling Machines. Here is another illustration of a machine typical of an entire class of machine tools available in large quantity at many W. A. A. Regional Offices, in standard makes and sizes.

BASIC TOOLS

GOVERNMENT-OWNED SURPLUS PRODUCTION EQUIPMENT

(second in a series of 4-page advertisements designed to inform industry of available machine tool surpluses)

Here, by the hundreds, are the tools you need to modernize your production and establish new enterprises—available *now* at low cost—at a time when a war-devastated world is exerting the biggest demand for goods and services ever known. You owe it to yourself, your organization, and your fellow men to put this productive capacity to immediate use. So check this list carefully. Find out which of these basic tools will help you solve immediate production problems. Then clip and mail the expediting coupon to the nearest War Assets Administration office listed on the next page. War Assets Administration is a government agency specially created to help you apply War Surpluses to post war needs.

ECK LIST OF SPECIAL MACHINE TOOL BUYS!

e are a few of the many thousands of machine tools now available through War Assets Administration.

KEY*	MACHINE (function)	TYPE	SIZE OR CAPACITY	Quantity Available Now
A—	Grinders	Race Radius—External		118
B—		Race Radius—Internal		72
C—		Contour Profile		75
D—	Screw Machine	Auto—Bar—Single Spindle	Up to 1½" cap.	1975
E—	Screw Machine	Auto—Bar—Five Spindles	All sizes	1515
F—	Screw Machine	Auto—Bar—Eight Spindles	1½" and Over cap.	380
G—	Engravers	Pantograph—2 Dimensions		70
H—	Honers	Internal—Horizontal	Under 6" Bore	175
I—		Internal—Vertical		129
J—	Lapping	Flat Surface Only	24" Diam. lap plate	107
K—	Polishers & Buffers	Floor Type	½ to 10 H.P.	1479
L—	Lathes	Speed Type	Up to 3 H.P.	1490
M—	Saws	Circular Cut-off		250
N—	Abrasive Machine	Belt Drum & Disc		580
O—	Abrasive Cut-off			112
P—	Tapping	Vertical—1 & 2 Spindle		457
Q—	Tapping	Horizontal—1 Spindle		259
R—	Die Threading	Belt Rotary—1 Spindle		390
S—	Centering	Double End—Horizontal		112
T—	Pointing, Chamfering & Burring			141
ZZ—	Gear Shapers	External & Internal	Up to 40" Diam.	
PP—		Spur—External only		
QQ—		Spur & Helical—External & Inte		
RR—		Spur & Helical—External only		
SS—	Gear Cutters	Bevel Type not inc		
TT—	Gear Tooth Finisher	Plainer Type Str. B		
UU—		Generating Type Grinding		
VV—	Gear Tooth Lapper	Formed Wheel Type		
WW—	Gear Tooth Shaver	External only		
XX—	Grinder	Comb. External & Internal		
		Rotary Type		
		External Cylinder—Plain		

KEY*	MACHINE (Function)	TYPE	SIZE OR CAPACITY	Quantity Available Now
U—	Shaver	(Not Gear)		104
V—	Reamer	(Not Rifle)		516
W—	Drawing Machine		100,000# and over	21
X—	Machinery & Equipment Allied to Primary Metal Forming Machine and Equipment	Pickling	All sizes	149
Y—	Straight Side Presses	Vertical—Single Action	5 to 100 Tons	165
Z—		Vertical—DoubleAction	5 to 100 Tons	111
AA—	Flame Cutting Machine			1631
BB—	Hardness Tester	Brinell—Portable & Power		200
CC—		Rockwell—Manual & Power		425
DD—	Inspection Machine	Magnetic (Magnaflux)		601
EE—	Balancing Machine	Static		93
FF—		Dynamic		67
GG—	Boring, Drilling & Milling	Horizontal	Under 3" to 6"	209
HH—	Boring & Turning Drills	Vertical	Under 36" to 120" Swing	683
II—	Boring Fixed Rail Tank Mill	Vertical		87
JJ—	Precision Boring Machines	Horizontal bridge—single end	Under 8" to 14"	486
KK—		Horizontal bridge—double end	Under 8" to 14"	226
LL—	Drills	Box column—single spindle	Under ½" Cap.	
			Up to 22" Swing	287
MM—			½" to 1" Cap.	
			16" to 24" Swing	
NN—		Round column—single spin	Under [illegible]	
OO—				
PP—				
			Swing	161
		Spec. Kingsbury Way & Vertical	Up to 32" Swing	296
	Gear Hobber	Horizontal	4" to 16" Cap.	250 / 321

*KEY letters are provided for your convenience in filling out the coupon to the right. They do not refer to any other listing of surplus property. If used in contacting War Assets Administration Regional Offices by letter, wire or phone, please refer to this advertisement.

EXPEDITING COUPON

Use this coupon to conserve your time. Circle by key letters the machines in the above group in which you are interested and mail to your nearest W. A. A. Regional Office.* We will determine in advance our stock situation on the machines and inform you quickly, without obligation.

To War Assets Administration:*
Do you have in surplus stocks the following circled machine tools? Where are they located? What is their condition?

A, B, C, D, E, F, G, H, I, J, K, L, M, N,
O, P, Q, R, S, T, U, V, W, X, Y, Z,
AA, BB, CC, DD, EE, FF, GG,
HH, II, JJ, KK, LL, MM, NN,
OO, PP, QQ, RR, SS, TT,
UU, VV WW, XX, ZZ.

I am also interested in the following machine tools not included in your list:.....

.....

.....

Name.....Tel. No.....

Firm.....

Address.....State.....

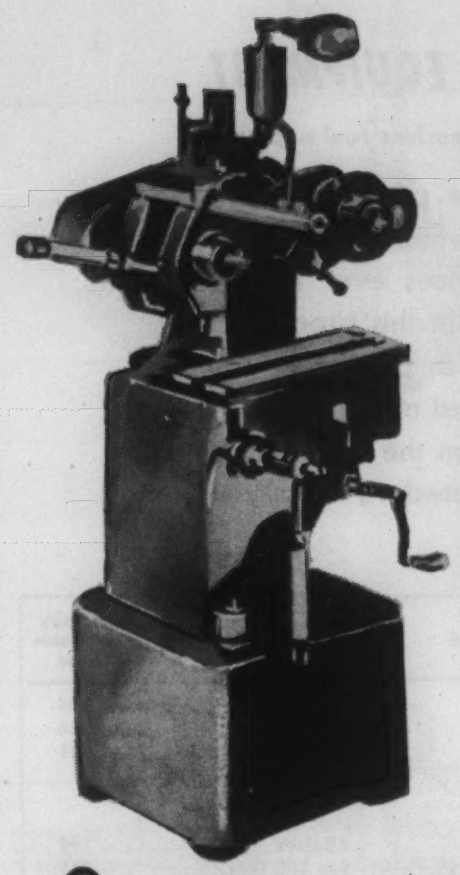
City.....

*For War Assets Administration address, see 4th page of this advertisement.

277-4

All items shown on this and preceding three pages are offered subject to prior sale. This surplus property has previously been advertised and offered to prior claimants including Veterans of World War II.

MILLERS



A Horizontal Hand-Feed Millers

For this and all the machine tools shown in this advertisement, simply contact your nearest War Assets Administration Office listed below, using the coupon provided. That office will know that large inventories of this miller, for example, are available in Boston, Detroit, Kansas City, and New York and how to get one or more for you.

GOVERNMENT-OWNED SURPLUS PRODUCTION EQUIPMENT

These milling machines, and the other surplus machine tools shown on the preceding 3 pages, were productive enough and modern enough to win history's biggest war. They were versatile enough to turn out some of the most intricate weapons of all times. As they stand—some used and some unused—they are the largest untapped source of peacetime productivity and profits in the U. S. today. With them you can modernize and speed up your production or establish new enterprises at lowest cost. And it's easy to do. As a first step in acquiring these machines, simply fill in and mail the coupons on this or the preceding 3 pages.

B Horizontal Miller (knee type) *These machines are located in quantity as follows.*

#1; under 28" Table Travel; New York, Boston, Detroit. #2; 28" to 34" Table Travel; Detroit, Cleveland, Boston. #3; 34" to 42" Table Travel; Detroit, Cleveland, Chicago and Philadelphia. #4; 42" to 50" Table Travel; Detroit, Cleveland. #5; over 50" Table Travel; Detroit, Cleveland, Chicago.

FREE INFORMATION

To War Assets Administration:

Without obligation, please send me detailed information on the milling machines checked at the right and on the following types not included in your list:

.....

.....

.....

277-4

MILLER CHECK LIST

(These key letters correspond to the machines listed in the table above. Simply check those in which you are interested.)

A E I
B F J
C G K
D H L

Name.....

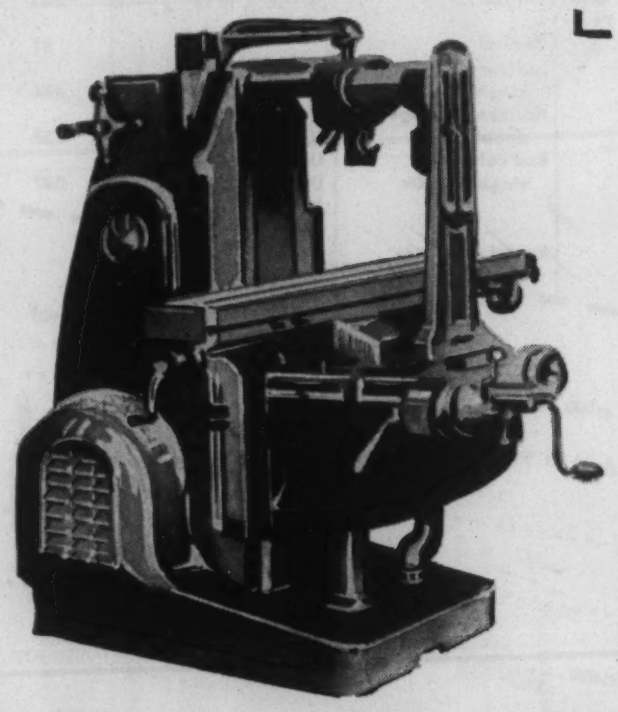
Tel. No.....

Firm.....

Address.....

City.....

State.....



SPECIAL MILLING MACHINE BUYS!

KEY	TYPE	SIZE OR CAPACITY	QUANTITY AVAILABLE NOW
A	Horizontal, Plain, Hand Feed	All sizes	564
B	Horizontal, Plain, Knee Type	#1 to #5	2,125
C	Vertical, Universal	#1 to #5	847
D	Auto Millers	All sizes	455
E	Bed Type, Plain, Horiz. Spindle	All sizes	2,703
F	Vertical Spindle, standard	All sizes	428
G	Vertical Fixed Bed Profiler	1 and 2 Spindles	847
H	Thread Millers—Universal (non-auto)	12" Work Dia. and up.	76
I	Thread Millers—Universal (auto)	Up to 20"	238
J	Thread Millers—Chucking (auto)		207
K	Planetary Milling Machines	6" Work Dia. and up	206
L	Spline Millers		248

WAR ASSETS ADMINISTRATION

OFFICES LISTED BELOW ARE TEMPORARILY IN RECONSTRUCTION FINANCE CORPORATION AGENCIES

Offices located at: Atlanta • Birmingham • Boston • Charlotte • Chicago • Cleveland • Dallas • Denver • Detroit Helena • Houston • Jacksonville • Kansas City, Mo. • Little Rock • Los Angeles • Louisville • Minneapolis Nashville • New Orleans • New York • Oklahoma City • Omaha • Philadelphia • Portland, Ore. • Richmond St. Louis • Salt Lake City • San Antonio • San Francisco • Seattle • Spokane • Cincinnati • Fort Worth (Tel. 3-5381)

FOR THE HEAT-TREATER...TWO TIMELY AIDS FROM CYANAMID!

1. Technical Bulletin supplying bibliography on Isothermal Heat-Treating, and index of S or TTT Curves.

2. Pocket "slide rule type" Calculator for ready determination of S or TTT Curves for 35 widely used steels.

Get both of these by writing or mailing coupon to Cyanamid today!

American **CYANAMID** *& Chemical Corporation*

(A Unit of American Cyanamid Company)

30 ROCKEFELLER PLAZA • NEW YORK 20, N. Y.

American Cyanamid & Chemical Corporation
30 Rockefeller Plaza, Dept. H
New York 20, N. Y.

Gentlemen:

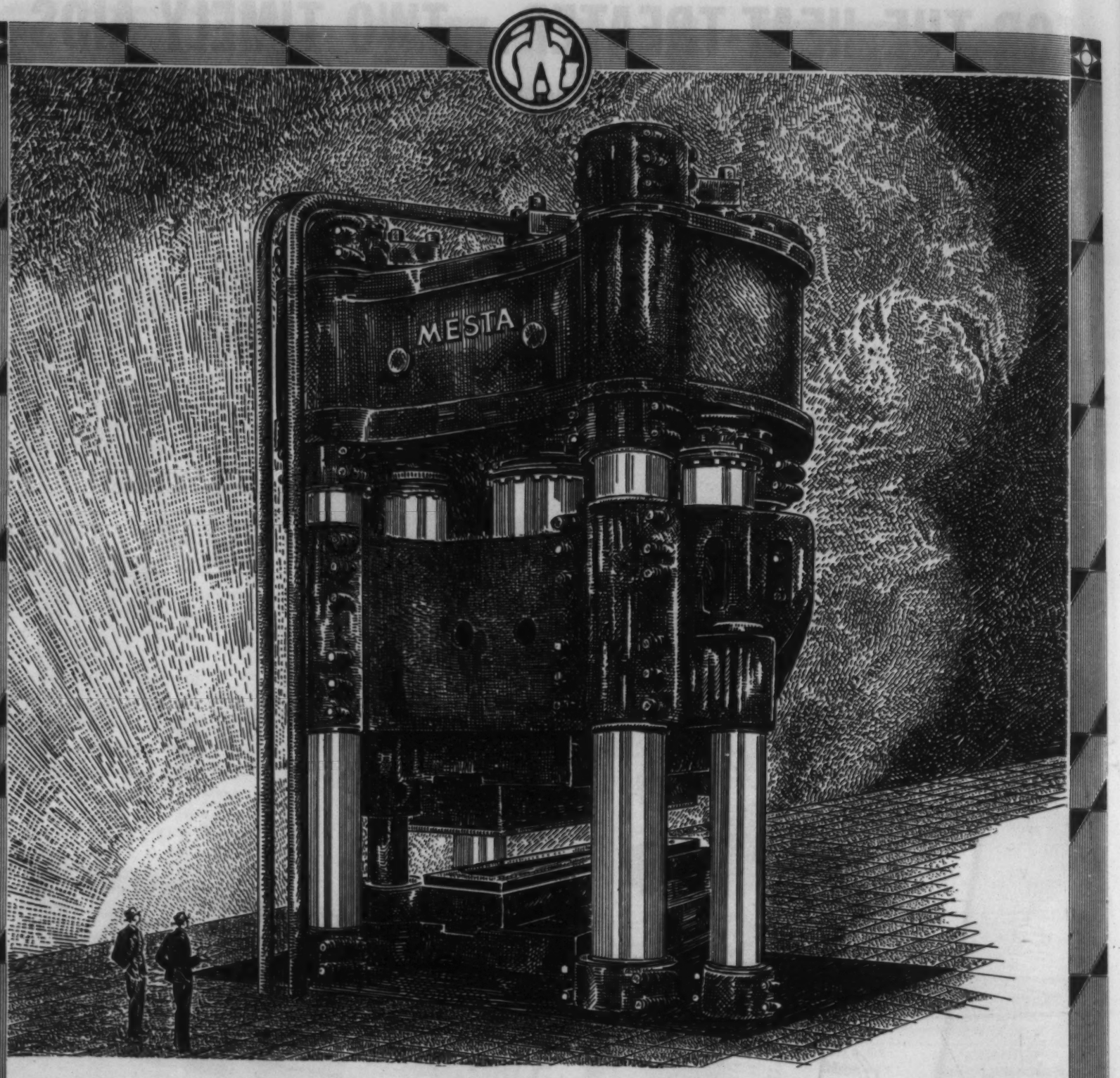
Please send me your Isothermal Bulletin No. 2 and slide rule.

Name_____

Company_____

Address_____ Position_____

City_____ State_____



Now in operation is the new plant of Wyman-Gordon Products Corporation, a wholly owned subsidiary of Wyman-Gordon Company for the account of Reconstruction Finance Corporation, available for experimentation in and for the development and production of light metal forgings. In operation here is the largest die forging press in the world (18,000 tons), that removes present size restrictions on magnesium forgings. This means for aircraft reduced weight which, in turn, means increased pay-load and greater performance for American planes . . . And for industry in general—complete range of magnesium and aluminum forgings.

WYMAN-GORDON
PRODUCTS CORPORATION
WORCESTER, MASSACHUSETTS, U. S. A.

ONE PURPOSE >> THE IMPROVEMENT OF METALS BY FORGING

Forged oil well drilling tool part in which grain structure and fibre-like flow lines inherent in steel have been utilized fully to obtain the maximum of metal qualities required to endure severe service conditions. Does not this sample indicate how parts in your product might be improved?

• Does the part you are designing require high strength, toughness, fatigue and wear resistance? While it is still in the design stage consult a Steel Improvement Forging Engineer or Metallurgist, or both, about how to obtain these qualities without the disadvantages of excessive mass and weight. He will be able to show you how to utilize fully the fibre-like flow line structure of wrought metals to obtain the utmost of every quality required to meet a specific service condition. He represents over 32 years of venturesome production effort devoted to the IMPROVEMENT OF METALS BY FORGING. Recent developments in the employment of forging techniques have made it possible to forge many unusual and so-called "impossible-to-forge" designs. Competitive advantages often result from the use of forgings. A product fortified by forgings out-performs and out-sells other products. Write or phone for engineering service.

★ ★ ★

Reference Data Booklet presents many new ideas on forgings and their applications in many different types of equipment. Copies available to engineers, metallurgists and executives.

DROP FORGINGS

THE STEEL IMPROVEMENT & FORGE CO.

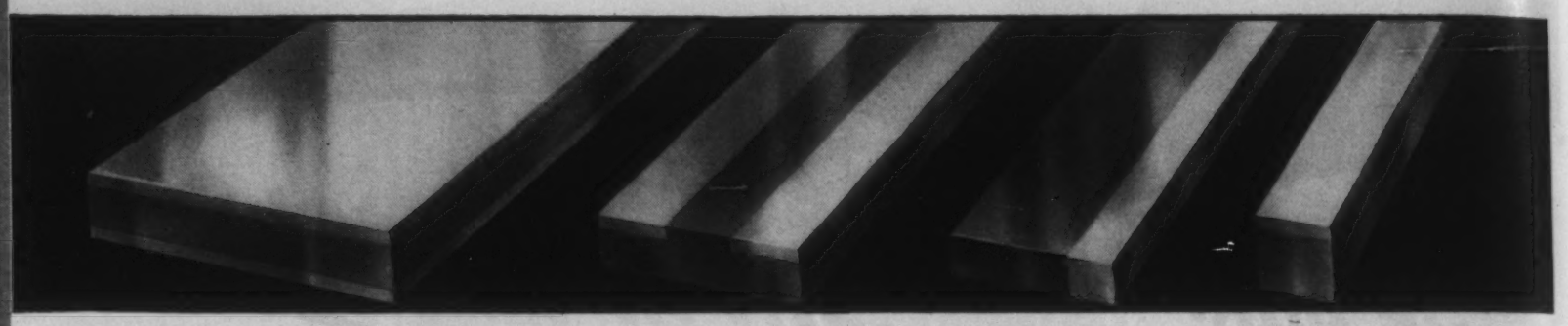
956 East 64th Street CLEVELAND, OHIO

Tulsa, Okla.—National Bank of Tulsa Bldg. • Los Angeles 28, Cal.—7046 Hollywood Blvd. • New York 7, N. Y.—225 Broadway

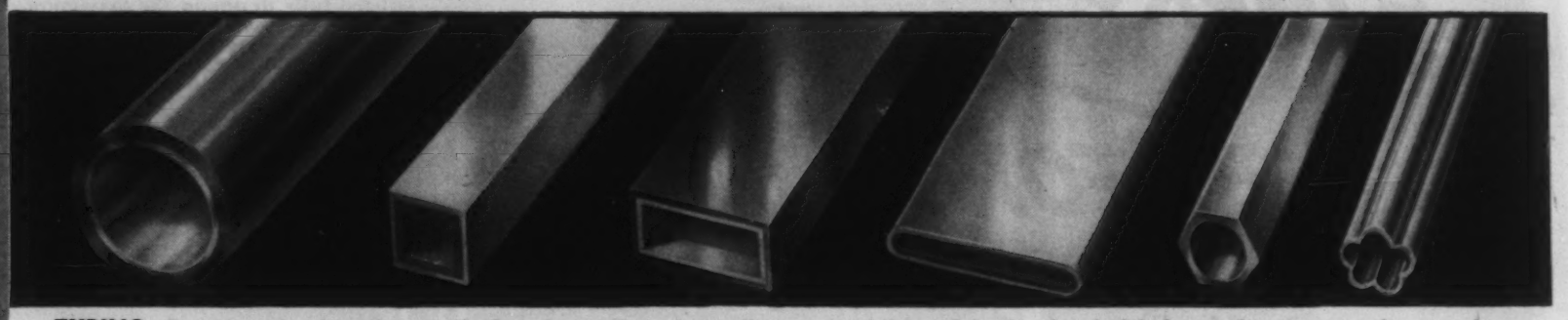
Laminated Precious Metals

make these things possible . . .

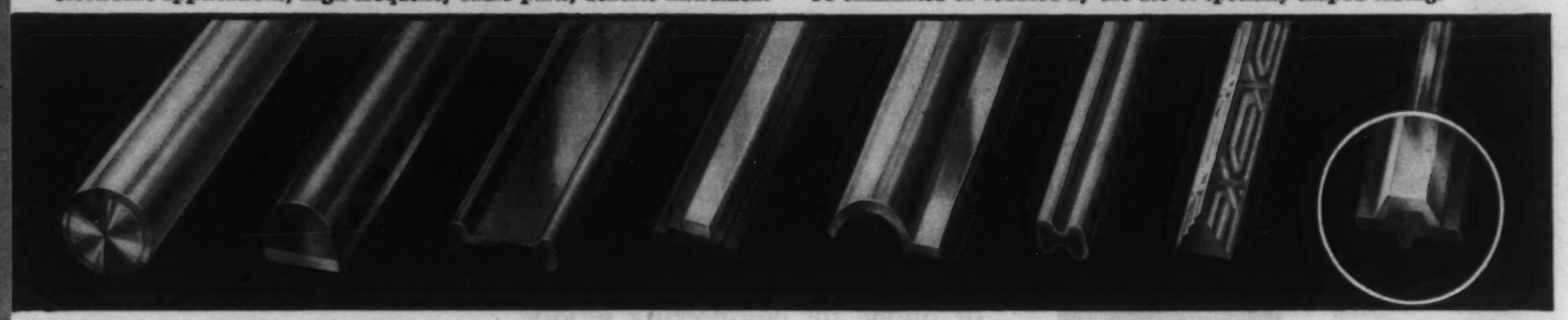
- **Desirable electrical, mechanical or chemical qualities of precious metals can be added to the strength or other desirable properties of base metals, precisely where and as required.**
- **Finer, more lasting finishes than are otherwise obtainable in base metals.**
- **Precious metal properties of corrosion resistance, electrical superiority, and durability can be obtained without solid precious metal costs.**
- **Uniform maintenance of lamination ratios with no porosity, pit marks or defects.**



SHEET: Sheet is manufactured in any combination of metals and in any quality or ratio, single or double plate or striped. A recently developed specialty is edgelay. Laminated sheet can be produced as thin as .003 of an inch; in widths from ⅛ inch wide to 6 inches wide, and within tolerances of .0001″ to .0002″ depending on the material. We are able to supply laminated or solid sheet with a fine mirror finish suitable for production of the finest precision parts or decorative pieces. Sheet or strip is supplied coiled or flat according to the customer's specifications and depending on the dimensions. From this sheet practically any form or type of product may be produced.



TUBING: Because our tubing is actually deep-drawn sheet, its quality is easily controlled. Dimensional limits lie between approximately .015″ O.D. to 2″ O.D. with wall thickness as small as .005″. Very close tolerances can be maintained both on wall thickness and diameters. Laminated tubing is now used in the electrical industry, for electronic applications, high frequency radio parts, delicate instrument assemblies and in the chemical industry, for non-corrosive containers and conveyors. In addition to round tubing, almost every other conceivable shape may be had, whether rectangular, octagonal, or star shaped, etc. Rings, sleeves and jackets are quickly and economically cut from laminated tubes. Machining and forming operations can often be eliminated or reduced by the use of specially shaped tubing.



WIRE: We draw wire to diameters as fine as .005″ to .006″ depending on the material, and the precious metal thickness can be held to a tolerance of .0001″. In spite of such small dimensions, such wires are often engraved for decorative purposes or shaped for industrial use. Laminated wires, available in every conceivable shape, are widely used in spectacle frames, in various instruments, for formed plated springs, low cost electric wire (silver coated steel), radio electronic parts, where expansion must be held to a minimum (silver on invar), and in chemical apparatus when corrosion must be prevented. We also make solder wire and preformed rings for straight line production.

To assist you in the application of our products to your products we are maintaining a staff of thoroughly experienced metallurgists, chemists, designers and consultants . . . an up-to-date research and testing laboratory . . . and a splendidly equipped tool room. These are all at your service to cooperate with your own staff to the full extent of our facilities.

Your inquiries are cordially invited. Ask, too, for a copy of our new descriptive folder on silver solders.

START RIGHT with **Makepeace** PRODUCTS

SHEETS • WIRE • TUBING • SOLDERS • FABRICATED PARTS AND ASSEMBLIES

D. E. MAKEPEACE COMPANY

Main Office and Plant, Attleboro, Massachusetts

NEW YORK OFFICE, 30 CHURCH ST. CHICAGO OFFICE, 55 EAST WASHINGTON ST.

NITRIC ACID . . . born in the reeking retorts of ancient alchemy . . . has been an invaluable tool of science and industry down through the ages. Even today, it still finds new, dramatic roles—such as in jet propulsion. Alone and as a component of mixed acid, this versatile product is irreplaceable for a host of applications ranging from explosives to engraving . . . from plastics to dyes. Scores of processes utilize its dual chemical characteristics as a strong acid and as a vigorous oxidizing agent.

GENERAL CHEMICAL HAS PROVIDED this basic chemical to American Industry for almost half a century . . . devoting continuous study to the product's properties and potentialities—and developing a wide range of grades and strengths for varying needs in production and laboratory.

• • •

IF YOU ARE A USER OF Nitric Acid, study the list at right. Here you will find a form of the product suitable for your requirements—always readily available from General Chemical's convenient plants and warehouses. Write or phone your nearest General Chemical Sales and Technical Service Office for full information.

GENERAL CHEMICAL COMPANY

40 RECTOR STREET, NEW YORK 6, N. Y.

Sales and Technical Service Offices: Atlanta • Baltimore • Boston Bridgeport (Conn.) • Buffalo • Charlotte (N. C.) • Chicago • Cleveland Denver • Detroit • Houston • Kansas City • Los Angeles • Minneapolis New York • Philadelphia • Pittsburgh • Providence (R. I.) • San Francisco Seattle • St. Louis • Utica (N. Y.) • Wenatchee • Yakima (Wash.)
In Wisconsin: General Chemical Wisconsin Corporation, Milwaukee, Wis.
In Canada: The Nichols Chemical Company, Limited
Montreal • Toronto • Vancouver

BASIC CHEMICALS
GENERAL CHEMICAL COMPANY
FOR AMERICAN INDUSTRY

Grades and Strengths of General Chemical Nitric and Mixed Acids

Standard Grades
36° Be 38° Be 40° Be 42° Be

Diamond Grades
Highest Quality Commercial Acid
36° Be 38° Be 40° Be 42° Be
52.3% HNO_3 56.5% HNO_3 61.4% HNO_3 67.2% HNO_3
Approx. Approx. Approx. Approx.

Nitric Acid 95%
Diamond & Standard (48.5° Be)
Low in Impurities

Other Commercial Grades
including Aqua Fortis, also available

Reagent Grades
B&A Quality
C.P. Reagent A.C.S. Sp. Gr. 1.42
Fuming, Sp. Gr. 1.49-1.50, Reagent
Red, Fuming, Sp. Gr. 1.59-1.60, Reagent

MIXED ACID
Varying proportions of Nitric and Sulfuric Acids up to 100% total acidity to meet customers' requirements.

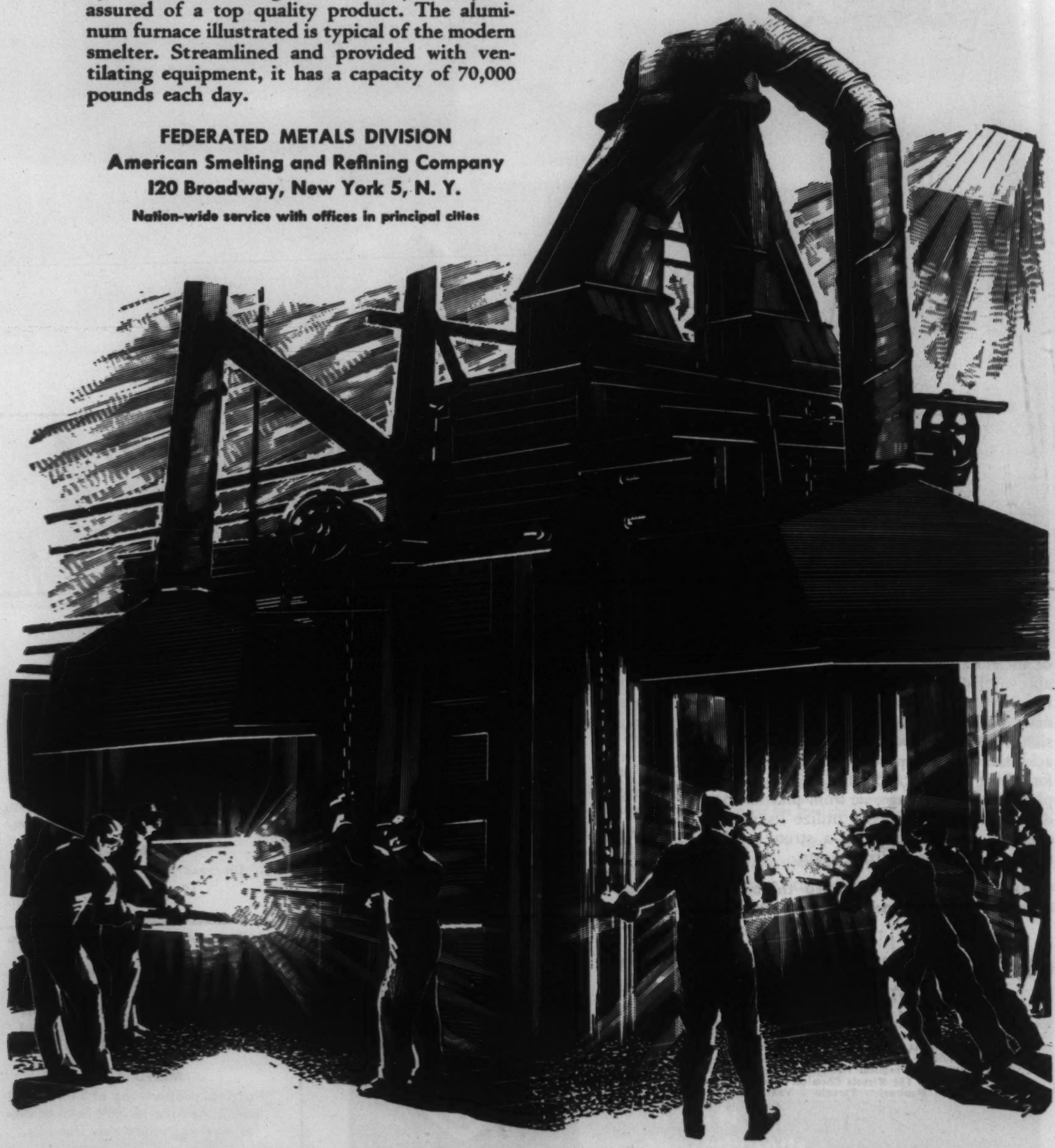
Federated — MODERN HEADQUARTERS FOR NON-FERROUS METALS

SMELTING—In the early days, furnaces were like Topsy, "they just growed". In Federated, furnace design is based on sound and tried engineering principles. Besides this, scientific instruments are used to control the operation of the furnace so that human failures can be minimized. Even more important is the metallurgical control and precise refining practice exercised while the metal is being processed. Each step in the process is carefully checked by trained metallurgists so that you may be assured of a top quality product. The aluminum furnace illustrated is typical of the modern smelter. Streamlined and provided with ventilating equipment, it has a capacity of 70,000 pounds each day.

FMD Federated

FEDERATED METALS DIVISION
American Smelting and Refining Company
120 Broadway, New York 5, N. Y.

Nation-wide service with offices in principal cities

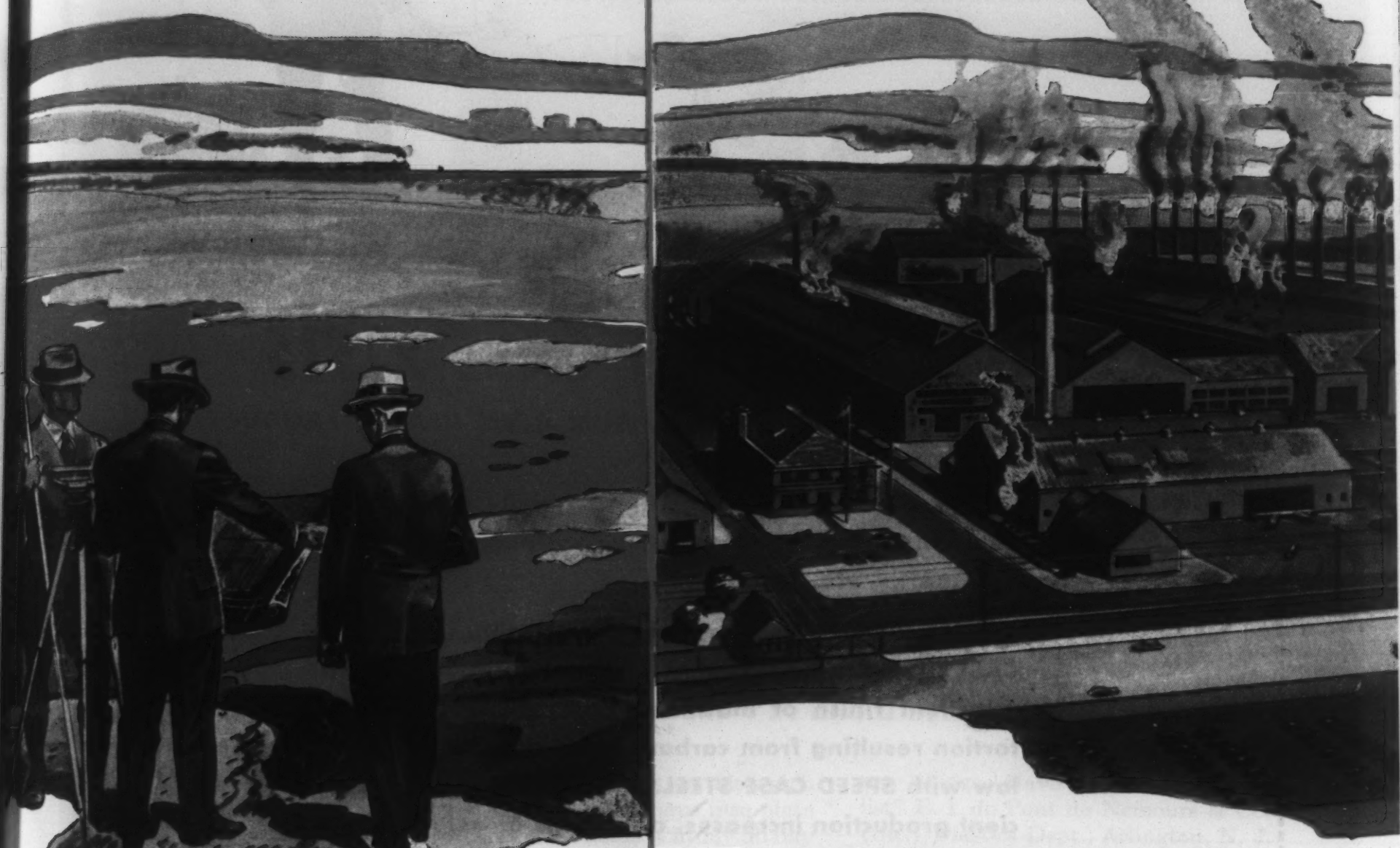


ALUMINUM • BRASS • BRONZE • BABBITT • DIE CASTING ALLOYS • SOLDER • TYPE METAL • ZINC DUST

From Site Survey To Point of Production . . .

UNITED

will Design, Build and Equip Your Complete Rolling Mill Plant



REG. T. M.

UNITED ENGINEERING and FOUNDRY COMPANY

Pittsburgh, Pennsylvania

Plants at Pittsburgh • Vandergrift • New Castle • Youngstown • Canton
Subsidiary: Adamson United Company, Akron, Ohio
Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England
Dominion Engineering Works, Ltd., Montreal, P.Q. Canada

Acting as engineers and general contractors on new plant projects, UNITED relieves your own organization of all construction and equipment problems.

Given basic requirements, UNITED will:

- **Survey your site.**
- **Erect all structures.**
- **Design, build and install all the machinery and equipment necessary to turn the plant over to you ready for operation.**

This complete UNITED service integrates all new plant construction details under one contract with responsibility vested in a single qualified organization. It is available to companies *the world over* whose new plant projects involve the rolling of ferrous, non-ferrous or even non-metallic materials.

The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment

HOW MANY PARTS ARE YOU "THROWING AWAY"

SPEED CASE x1515

A LOW CARBON OPEN HEARTH PRODUCT

SPEED CASE x1515 Steel will materially reduce your rejections, now due to excessive warpage, bad finish, tool marks, etc.

The unusually high free machining qualities of SPEED CASE (250 S.F.P.M.) assure increased production with excellent finish of machined parts maintained. Distortion resulting from carburizing is reduced to a new low with SPEED CASE STEEL. Many plants report sufficient production increases, or savings on rejections, to pay for the steel.

Write for our Brochure which gives complete data and Case Histories furnished by our customers.

Tear this off . . . ATTACH TO YOUR LETTERHEAD AND MAIL TO EITHER COMPANY BELOW

Licensor

MONARCH STEEL COMPANY

HAMMOND · INDIANAPOLIS · CHICAGO

PECKOVER'S LTD., Toronto, Canadian Distributor

MANUFACTURERS OF A COMPLETE LINE OF COLD FINISHED CARBON AND ALLOY STEEL BARS

Licensee for Eastern States

THE FITZSIMONS COMPANY

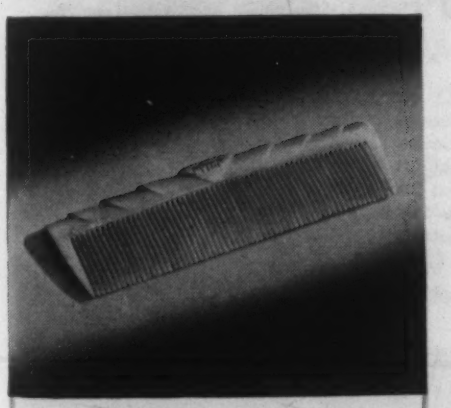
YOUNGSTOWN, OHIO

ACTUAL PHOTOGRAPH

Speed Case (.20 carbon) 1 inch cold drawn bar tied in a knot, without fracture.

STRAP . . . WITH A SNAP

A couple of bumps on a polythene band . . . and a new idea is born



WHAT'S NEW

Combs of Du Pont nylon have many advantages. They are strong, long-lived, and can be steam-sterilized. Look for the name nylon stamped on each comb. Nylon bobby comb (above), barber combs, dressing combs are manufactured by Columbia Protektosite Co., Carlstadt, N. J.

No seams, no buckles on this watch strap! Press the two snaps into place . . . and friction holds it firmly all day long. All year long, too . . . for Du Pont polythene is flexible, tough, and resistant to water and perspiration.

This new and better watch strap, made quickly and economically by injection-molding the plastic . . . is what *one* man saw in polythene. Another man saw—and produced—a polythene household tumbler. Still another wanted a heat-resistant material for zippers—found it in Du Pont nylon.

An idea for a better product is not enough. It becomes a product only when the man who conceives it finds the material with just the combination of properties it needs. Du Pont has some new plastics since the war began . . . and some of the older ones can do new things. Have you the complete list? E. I. du Pont de Nemours & Co. (Inc.), Plastics Dept., Arlington, N. J.

"Pla-Safe" watch straps *of Du Pont polythene are made in several attractive colors. Made by Pla-Safe Plastics Corp., Buffalo, N. Y.*

DU PONT
REG. U. S. PAT. OFF.
Plastics
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

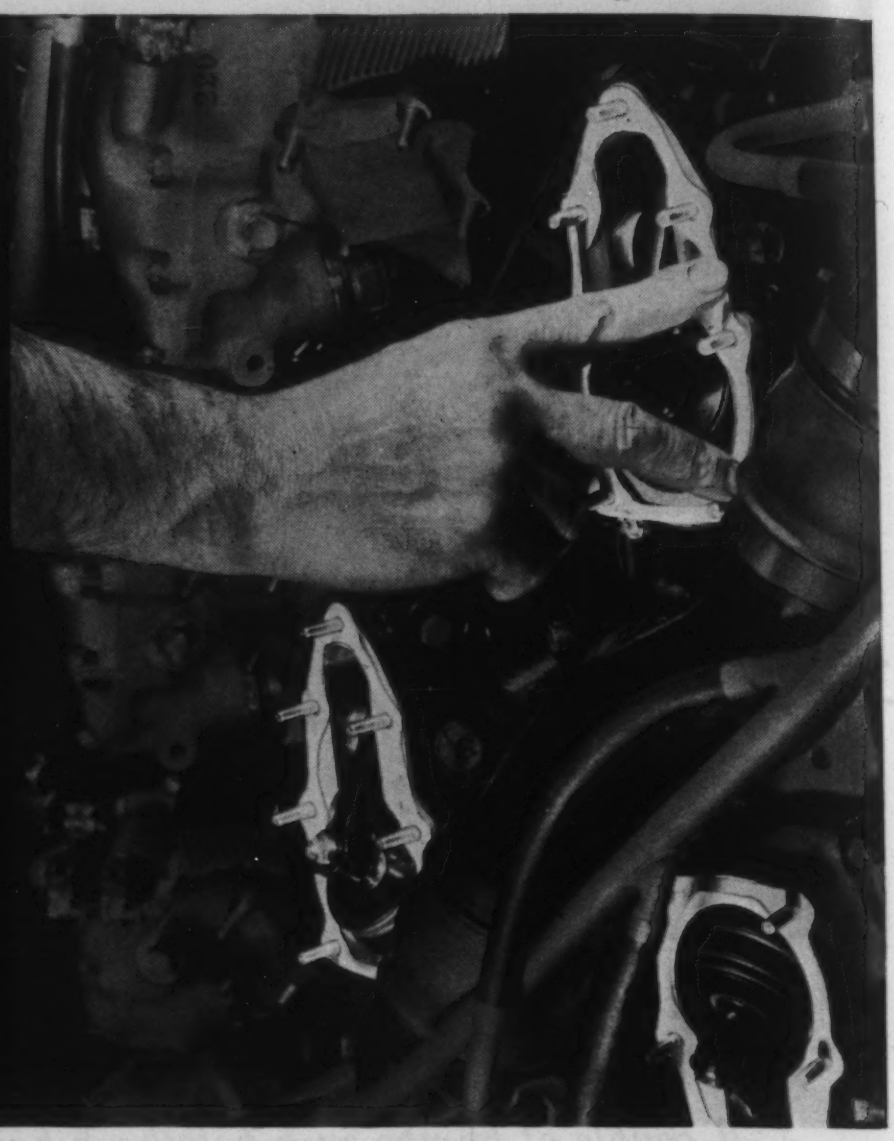
DC
DOW CORNING
SILICONES

SILASTIC
FLUIDS
VARNISHES
RESINS
GREASES

withstand heat
resist oxidation
exclude moisture

SILASTIC* GASKETS

for the
most powerful aircraft
engine ever built!



chosen best among all gasket materials tested for service at 450°F.

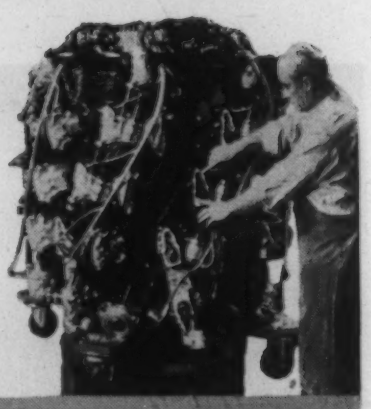
"NOTHING BUT THE BEST!" That's the policy followed by Pratt & Whitney in selecting materials for the powerful new 28-cylinder, 3650 h.p. Wasp Major.

That's why Silastic was chosen for these rocker box gaskets. Factors in the choice were Silastic's resiliency at the 450°F. operating temperature, resistance to the hot oil, and convenience in handling.

Silastic will fly with the Wasp Major in such giant new airliners as the Boeing Stratocruiser, Douglas Globemaster, Martin Mars, and Republic Rainbow.

If you need a rubber-like material that's resilient up to 500°F. and flexible down to −70°F., call for "Silastic Facts" No. 1A—and *TRY SILASTIC!*

*Trade Mark, Dow Corning Corporation



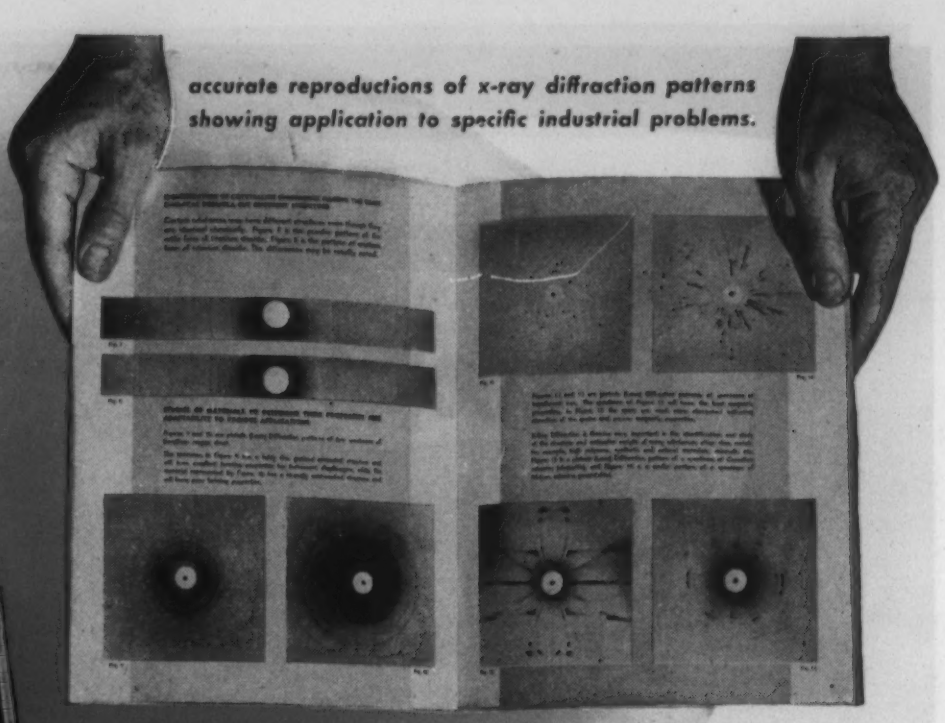
Silastic gaskets fabricated from Dow Corning silicone rubber by the Connecticut Hard Rubber Co. seal 56 rocker boxes of the 28-cylinder Pratt & Whitney Wasp Major.

Dow Corning
FIRST IN SILICONES

DOW CORNING CORPORATION · MIDLAND, MICHIGAN

Chicago Office: Builders' Building Cleveland Office: Terminal Tower
New York Office: Empire State Building
In Canada: Dow Corning Products Distributed by Fiberglas Canada, Ltd., Toronto

this helpful guide



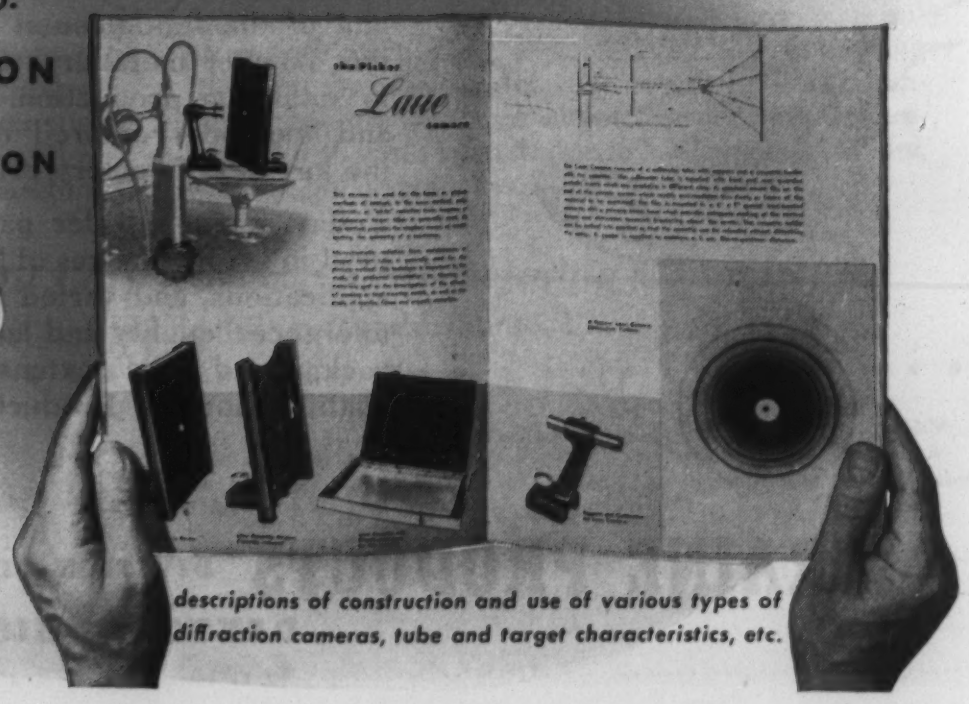
can bring you up-to-date on uses of x-ray diffraction . . .

You've heard of the remarkable contributions x-ray diffraction has made to many urgent wartime problems (in the development of synthetic rubbers, use of steel in shell cases, improvements in plastics, among others). Its applications are so diverse that in many plants today x-ray diffraction has become an indispensable routine tool for rapid physical and chemical determinations, research in product improvement and design, studies in waste reduction. This Picker Bulletin No. 1245, just published, discusses many phases of application, types of apparatus, techniques employed. It will be helpful in the evaluation of the method in your own problems. *Send for it today.*

Picker Bulletin No. 1245 is available without cost or obligation. Simply ask for it (on your letterhead, please, to either of the addresses below).

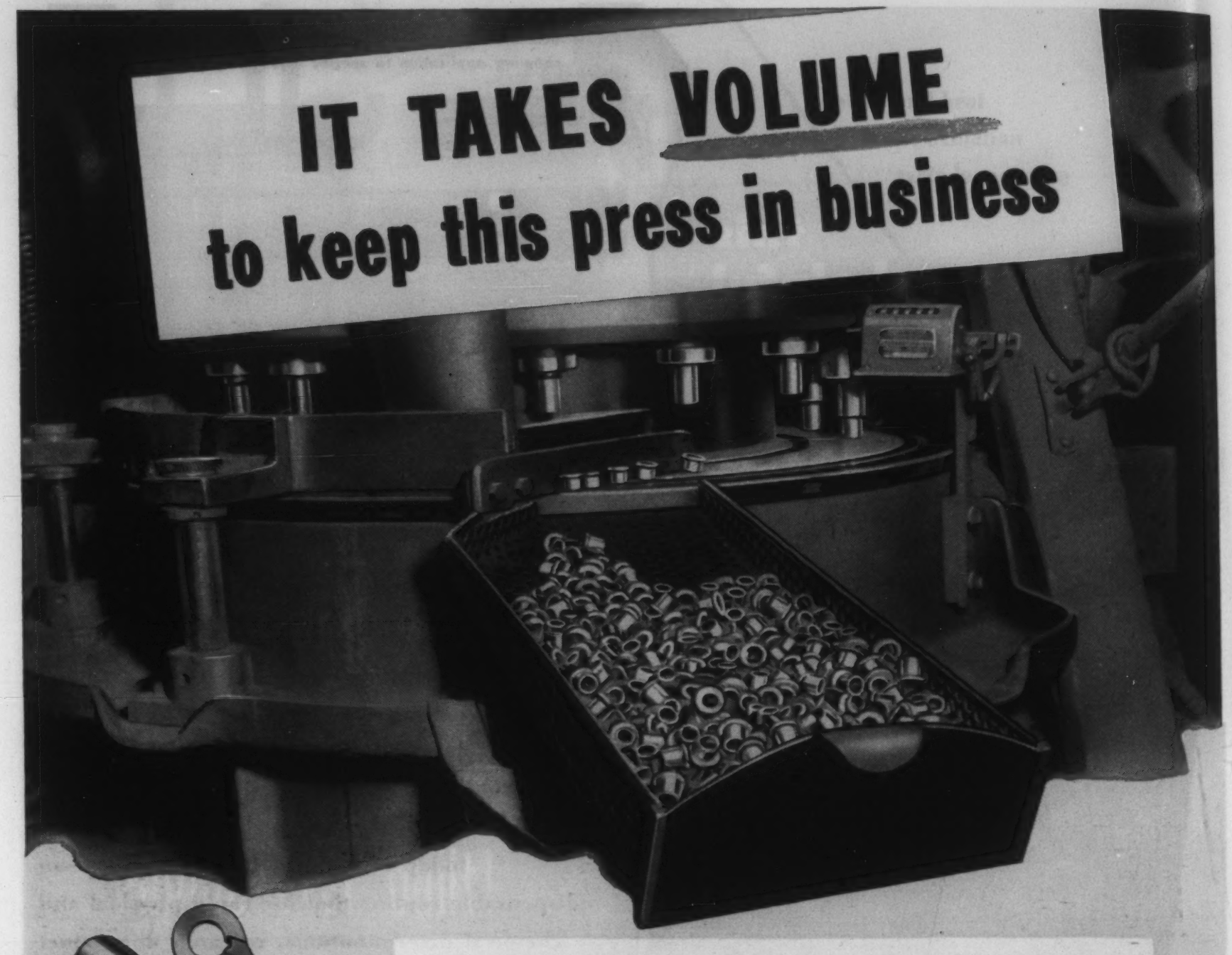
PICKER X-RAY CORPORATION
300 Fourth Avenue, New York 10, N. Y.

WAITE MANUFACTURING DIVISION
17325 Euclid Avenue, Cleveland 12, Ohio



descriptions of construction and use of various types of diffraction cameras, tube and target characteristics, etc.

IT TAKES VOLUME
to keep this press in business



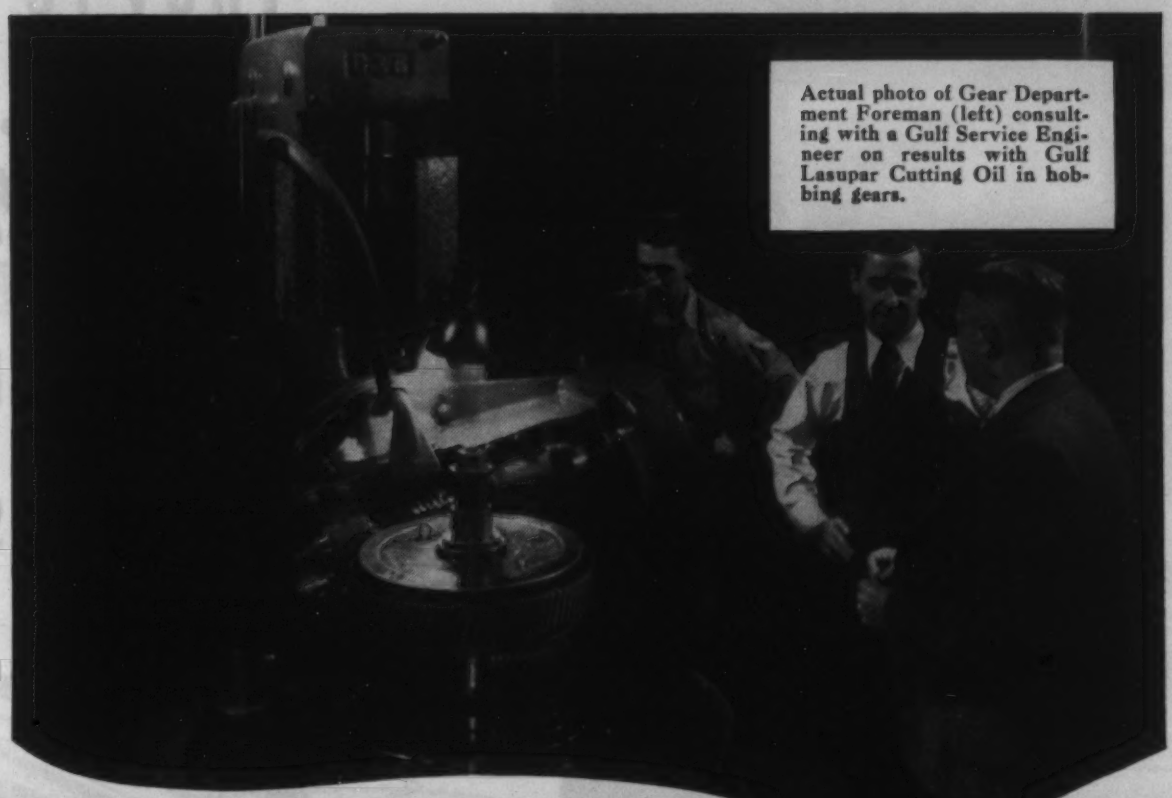
Powder metallurgy has "come of age" at Moraine Products.

It has graduated from the "job shop" stage and taken on a mature assignment in the manufacturing operations of our customers.

By demonstrating what *can* be accomplished through powder metallurgy in the economical production of parts for varied industries, Moraine Products has also determined what *cannot* be accomplished economically. And one of the fundamental limitations is based on the fact that powder metallurgy does not lend itself economically to small-run production. The very nature of the tooling and methods required makes large, continuing volume the key to satisfactory pricing and delivery.

Today, metal powder parts from Moraine Products are used in leading makes of household appliances, automotive applications, and varied products which call for practical tolerances, quality and large volume. A broad engineering background and extensive manufacturing experience qualify Moraine Products for this responsibility.

MORAINE PRODUCTS DIVISION OF **GENERAL MOTORS**
DAYTON, OHIO



Actual photo of Gear Department Foreman (left) consulting with a Gulf Service Engineer on results with Gulf Lasupar Cutting Oil in hobbing gears.

"With Gulf Lasupar Cutting Oil we increased production over 40% and get an extremely smooth finish"

says this Foreman

"GULF LASUPAR CUTTING OIL has proved superior to all other cutting oils we tested for hobbing gears," says this Foreman. "With this fine cutting oil, we increased production 40 per cent, and get an extremely smooth finish."

Here's a cutting oil that offers important help to you in the coming "battle of costs"! Gulf Lasupar Cutting Oil has the combination of characteristics needed to handle the modern steels. It works well at speeds once thought impossibly high. It cuts machining costs—often improves production as much as 50 per cent, and meets requirements for an exceptionally fine finish on the work.

Call in a Gulf Service Engineer today and let him demonstrate how this cutting oil can help you improve your machining practice. Gulf Lasupar Cutting Oil—and the other quality cutting oils in Gulf's complete line—are available to you through 1200 warehouses in 30 states from Maine to New Mexico. Write, wire, or phone your nearest Gulf office.

Gulf Oil Corporation · Gulf Refining Company

Gulf Building, Pittsburgh 30, Pa.

GULF INDUSTRIAL LUBRICATION

GULF QUALITY CUTTING OILS

Gulf Lasupar Cutting Oils A, B, and C
Gulf Electro Cutting Oils A, B, and C
Gulf M-L Cutting Oils A, B, and C
Gulf Cut-Aid · Gulf Cutx B · Gulf L. S. Cutting Base A and B

Gulf Oil Corporation · Gulf Refining Company M&M
3800 Gulf Building, Pittsburgh 30, Pa.

Please send me, without obligation, a copy of the booklet, "Gulf Cutting Oils," which includes a helpful Machining Guide.

Name.....

Company.....

Title.....

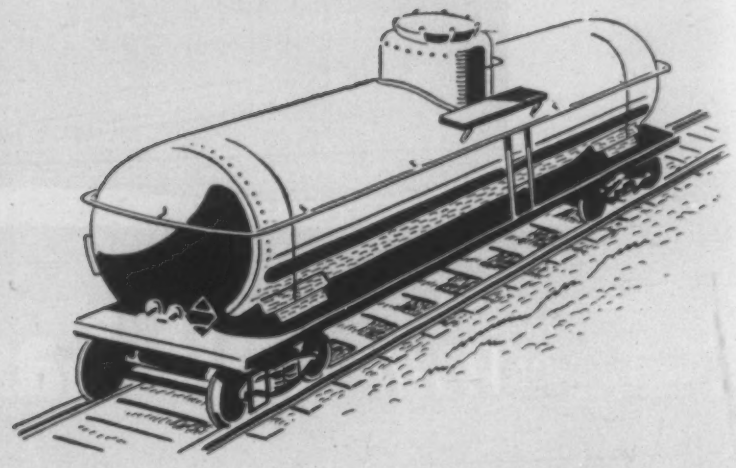
Address.....

About 50 all-aluminum tanks for tank cars are now being built by General American Transportation Corporation.

An automatic Lincoln "Electronic Tornado" carbon-arc welds the inside longitudinal seam of the shell structure, at a speed of 12 inches per minute.

Welding the tank dome manually using Alcoa flux coated electrodes with a metallic arc.

They're *Welding* All-Aluminum Tank Cars



Aluminum tank cars are now a "production" item. About 50 are being built or are on order by General American Transportation Corporation of Sharon, Pennsylvania. And speeding that production is Lincoln Electric Company's "Electronic Tornado" automatic carbon-arc welding machine.

Each shell—31 feet long by 78 to 87 inches in diameter—is made up of ½-inch and ⅝-inch Alcoa Aluminum plate. Alcoa Alloys are used because of their superior performance in the presence of the chemicals to be hauled in these cars.

Whether you've a question on *how* to employ aluminum to best advantage, which fabricating methods to use, or what alloys, Alcoa can help determine the answers. For such assistance, call the nearby Alcoa office, or write:

ALUMINUM COMPANY OF AMERICA, 2162 Gulf Bldg., Pittsburgh 19, Pennsylvania.

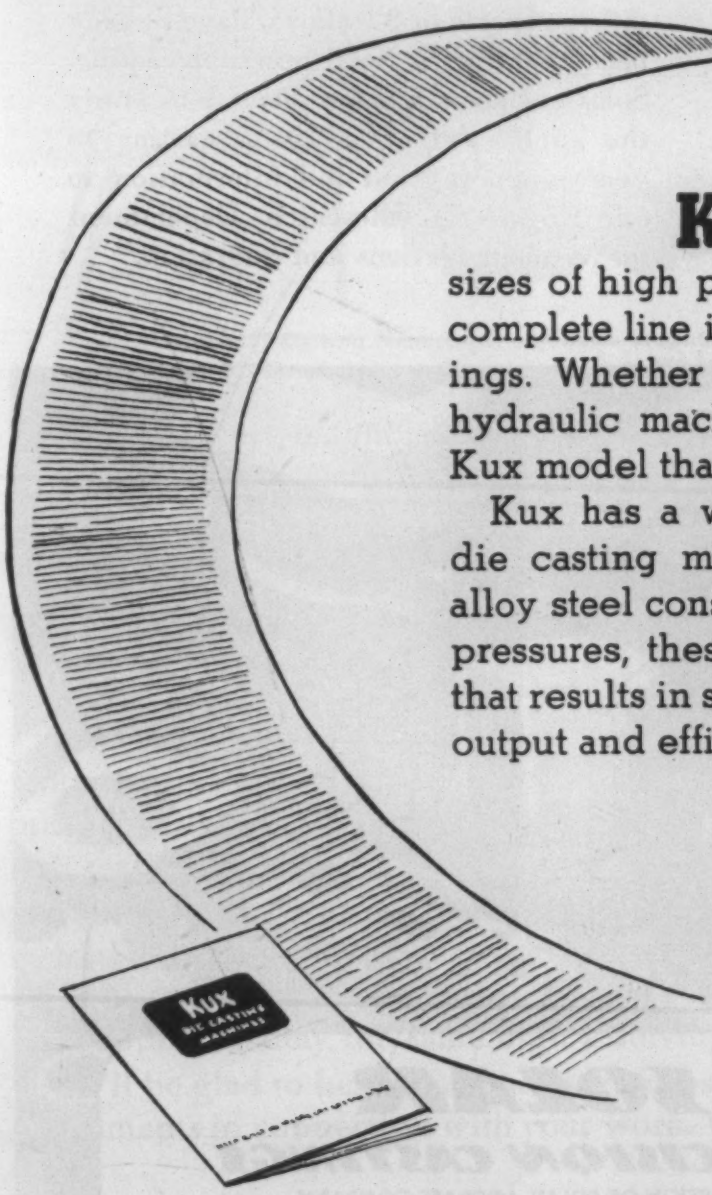
ALCOA FIRST IN **ALUMINUM**

ALCOA ALUMINUM

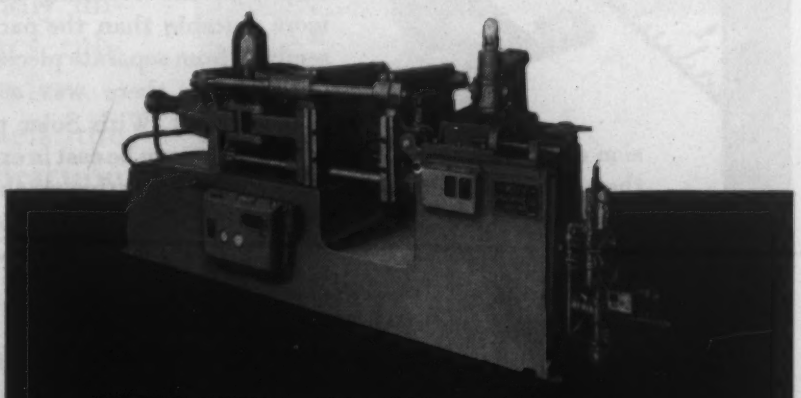
There's a KUX die casting machine that will fill the bill!

Kux produces over 15 different types and sizes of high pressure die casting machines—the most complete line in the country for Zinc or Aluminum castings. Whether it's an air operated or a self-contained hydraulic machine you're looking for, you will find a Kux model that meets your needs.

Kux has a world-wide reputation for high pressure die casting machines. Built of massive, extra strong alloy steel construction with high injection and locking pressures, these machines have a simplicity of design that results in safe operation, yet produces the maximum output and efficiency.



Write Dept. 27 for this complete catalogue which contains full specifications and illustrates the many models which are being used by die casting producers all over the country.

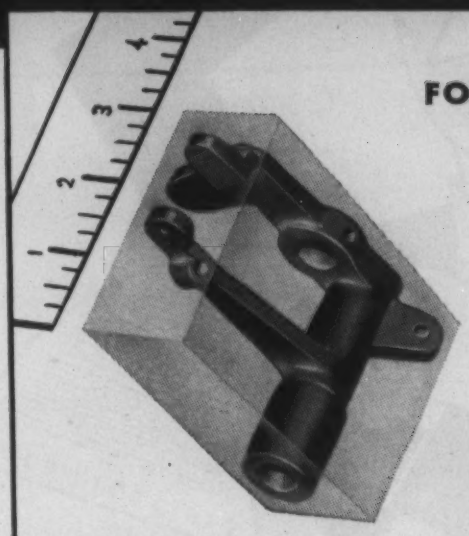


When you have a die casting problem, remember

KUX machine co.

2924-44 W. Harrison St., Chicago 24, Illinois

Here's What PRECISION CASTING Can Do!



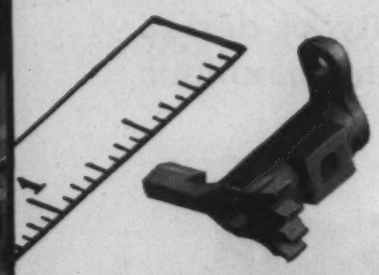
FORMERLY CUT FROM SOLID STEEL

This blank of a control mechanism part was formerly cut and machined from a 7½ lb block of solid steel. This involved 12 machine operations and tied up valuable equipment. The part was Solar precision cast in the exact shape required, at an appreciable saving in cost. Furthermore, the finished piece was superior in design.

MORE EFFICIENT SHAPE MADE POSSIBLE

The production of this hollow supercharger bucket posed a difficult problem. When the bucket was made from heat-resisting tubing, the metal was damaged during folding. Furthermore, only a symmetrical shape could be obtained. A Solar precision casting provided the exact shape required to increase efficiency, and provided it in the proper alloy.

CAST IN ONE PIECE - SAVED 32%



It formerly took four different pieces, each separately machined and assembled, to make this small typewriter part. Solar *precision cast* the part in *one* piece. Not only was the resulting casting more suitable than the part assembled from separate pieces but, in addition, there was a 32% saving in cost. With Solar precision casting, even small, intricate parts can be cast in exactly the metal desired to such precision tolerances that machining is greatly reduced.

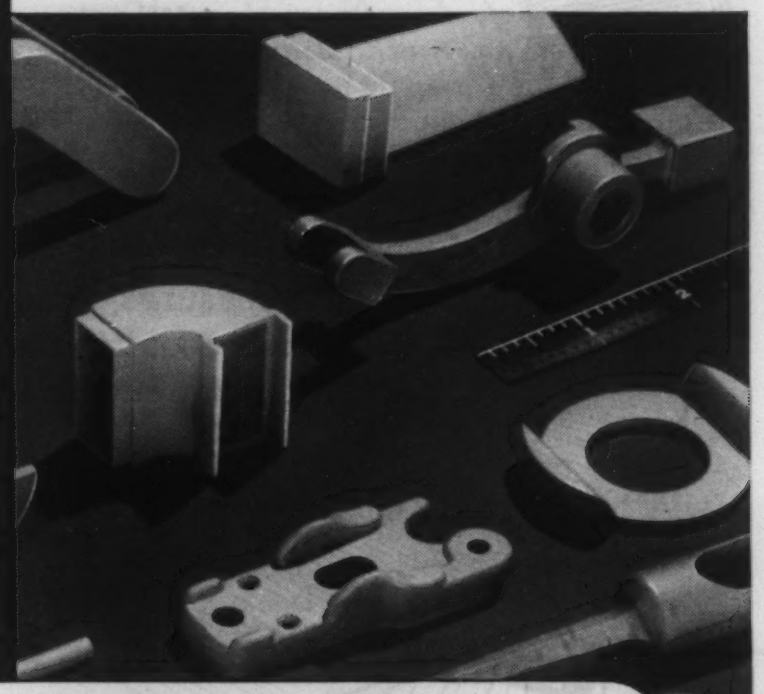
Casts Practically Any Metal in Intricate Shapes to Precision Tolerances.

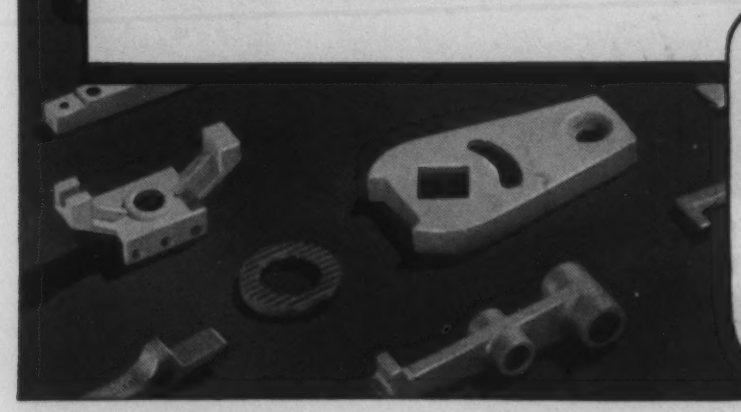
• • • •

Reduces Machining

Solar precision casting is a new method of producing small, intricate parts to such close dimensional tolerances that little or no machining is necessary. Many of the hardest metals and the new heat, chemical, and corrosion-resisting alloys—which cannot be readily machined or forged, can be precision cast.

Over 5,000,000 pieces, involving 614 different parts in 52 alloys, have already been produced by Solar precision casting. Solar engineers will be pleased to study the application of precision casting to your product. Send full information to our Engineering Research Department for recommendations and quotation.





SOLAR

PRECISION CASTINGS

A DIVISION OF SOLAR AIRCRAFT COMPANY

1810 Grand Ave.
Des Moines 5, Iowa

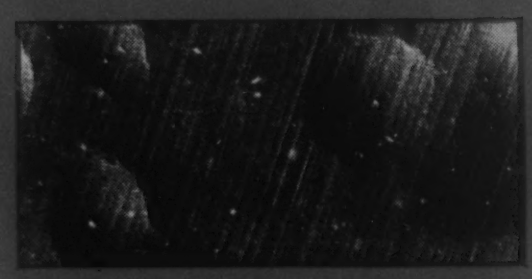
60 E. 42nd St.
New York, N. Y.

Speed research...see things you've never seen before...improve product quality

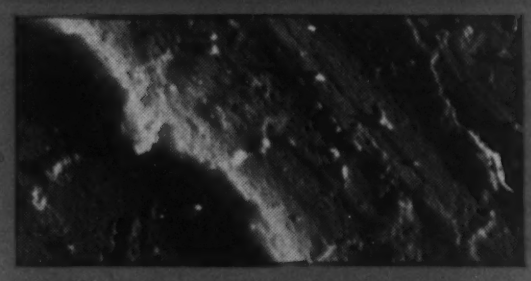
These RCA electron microscopes will multiply your vision 100,000 times

"Universal" Electron Microscope: adjustable magnifications up to 20,000 X. Sharp photographic enlargement to 100,000 diameters.

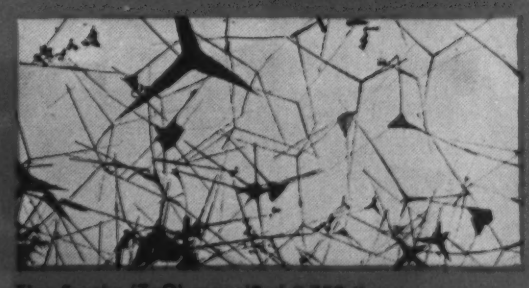
Console-type Electron Microscope: magnification 500 X and 5000 X; useful photographic enlargement to 100,000 diameters.



A polished face of a diamond 7,700 X—Note residual polish marks and pits in elevations.*



Surface of a used roller bearing (inner surface of the outer cone).*



Zinc Smoke (ZnO) magnified 2,750 times.

*A collodian replica, metal-shadowed to produce three-dimensional effect. Courtesy R. W. G. Wyckoff and R. C. Williams.

IF A DIME were magnified 100,000 times it would be more than a mile in diameter; a human hair would be the size of a giant redwood tree; a blood corpuscle would resemble a sofa pillow.

This magnification power, made possible by these RCA electron microscopes, has opened up a wealth of new opportunities for research, production, process control, and analysis.

During the few short years they have been available, these remarkable instruments have solved hundreds of vitally important problems relating to metals, chemicals, plastics, rubber, textiles, and petroleum products—to name just a few.

The RCA electron microscope comes in two models: the de luxe "Universal" type incorporating an electron diffraction camera and the compact, less expensive desk model. Both have approximately the same high resolving power.

We'll be glad to help you appraise the possibilities of these instruments in connection with your work. Write Dept. 52-F.

SCIENTIFIC INSTRUMENTS

RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

Why Heat Treat Specialists Specify CARBOFRAX Hearths

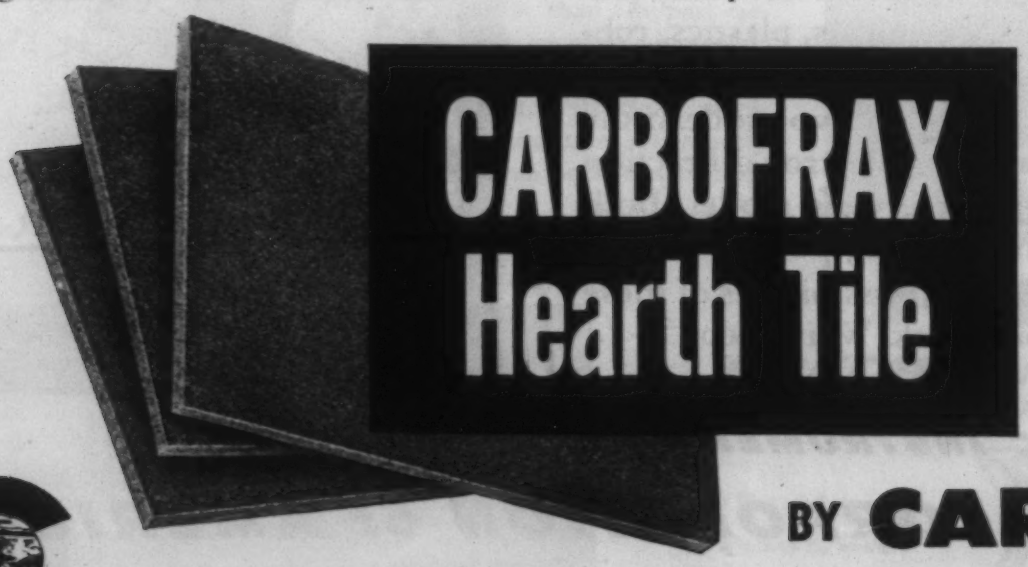
When a large well-known commercial heat treater equips furnaces 100% with CARBOFRAX silicon carbide hearths... you can be sure there are plenty of sound reasons back of the decision. Here are just a few from one typical case.

- Over 4 times the service life of ordinary refractories under the same operating conditions.
- Furnaces respond faster—production is speeded—furnace capacity is increased.
- Uniform temperatures are maintained throughout working chamber—minimizing rejects.
- Fuel costs are reduced—cuts labor and maintenance expense.

Summed up, these advantages point directly to increased furnace efficiency... better work turned out faster at less cost.

CARBOFRAX hearths combine many outstanding features. As an example... thermal conductivity is 11 to 12 times greater than ordinary refractories, the ability is there to carry heavy loads at high temperatures, and there is tough resistance to cracking, spalling and abrasion.

These advantanges are not limited to large applications alone. Whether you operate one furnace or many—large or small—it pays to look into all the facts. One of our experienced engineers will be glad to talk it over with you at your convenience. Write Dept. K-66, The Carborundum Company, Refractories Division, Perth Amboy, New Jersey.



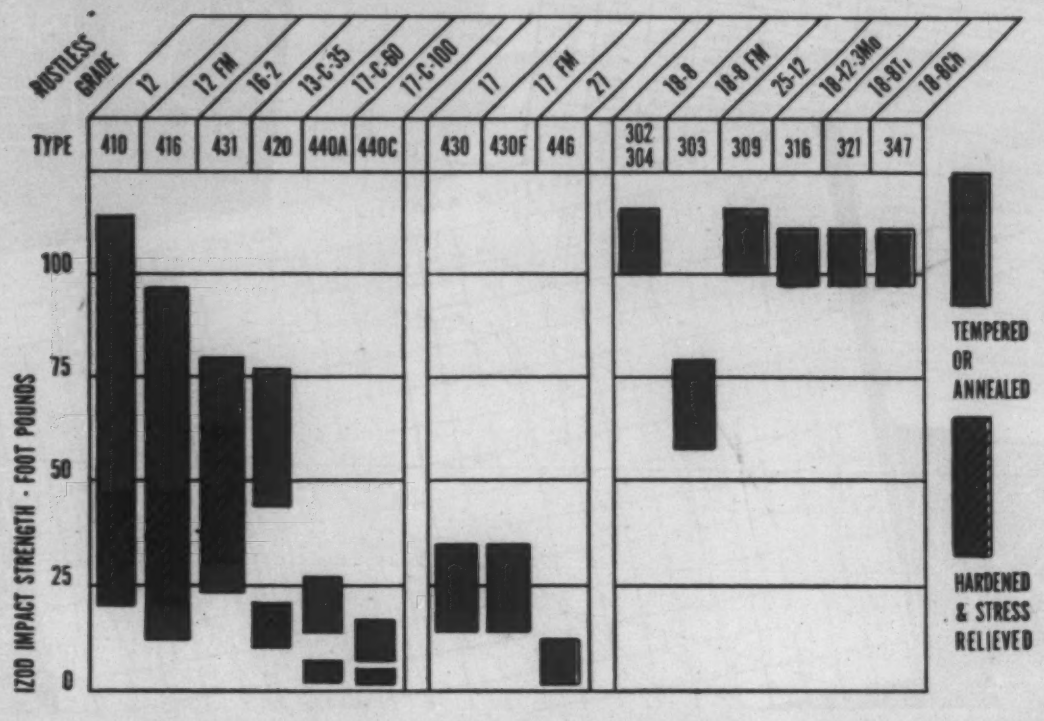
BY CARBORUNDUM
TRADE MARK

"Carborundum" and "Carbofrax" are registered trademarks which indicate manufacture by The Carborundum Company

RUSTLESS DATA SHEET NO. 4

Corrosion Resistance Plus Toughness

One of the Many Combinations of Properties Offered by Stainless Steels



IZOD impact values, as shown in the above chart for all standard grades of stainless steels, may not represent true mechanical properties directly usable in engineering design, but they are an indication of the great notch toughness offered by stainless steels. The energy in foot-pounds absorbed in breaking the notched test specimen results in stress concentration which is undoubtedly far greater than will occur in any well-designed product in service. However, stress concentrations cannot always be predicted or eliminated and it is often necessary to avoid the safety hazard by using a material which has the capacity to distribute a load at a notch, especially when corrosive attack can cause the "notch." Stainless steels are such materials.

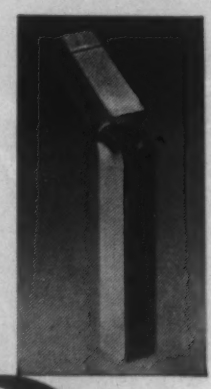
Depending upon the condition, whether hardened or annealed, the martensitic (group on left) show a variation of impact values. The austenitic or chromium-nickel grades (group on right) exhibit extremely high values—higher than any standard engineering alloy. The latter also have the remarkable property of retaining their great toughness at temperatures far below zero. For this reason type 304 stainless steels have been widely used for equipment handling liquid oxygen and nitrogen at hundreds of degrees below zero Fahrenheit. At 100° F. this grade has an Izod impact range of 105-125 foot-pounds. Large quantities have been used in essential working parts of high flying aircraft.

Considering versatility as an important design and fabrication requirement, it can be said that stainless steels offer extreme toughness but still retain adequate workability. Fabricating stainless steels is just different—not difficult. If you need a material to withstand both corrosion and shock stresses, one of Rustless' stainless steels may be your answer.

As engineering materials, stainless steels offer designers durability, strength, stiffness, economy and sales appeal, in addition to this quality we call toughness. Of course, the proper grade should be selected to meet specific conditions of service and fabrication. That is where Rustless' specialized stainless-steels experience can help. Consult us on your design problems.

• • •

This is a notched Izod impact test specimen after it absorbed a force of 82 foot-pounds at room temperature. The grade is Rustless 18-8FM, Type 303 which, incidentally, is machinable at rates exceeding 75% of those used for Bessemer screw stock. It will resist severe corrosion conditions, too. Quite a material!



Valuable Rustless booklets and leaflets are freely available to you, providing technical data, machining methods, how to electropolish stainless, how to blacken it, etc. Write for complete list of available Rustless publications.

STAINLESS STEEL SPECIALISTS

Rustless

DIVISION OF ARMCO

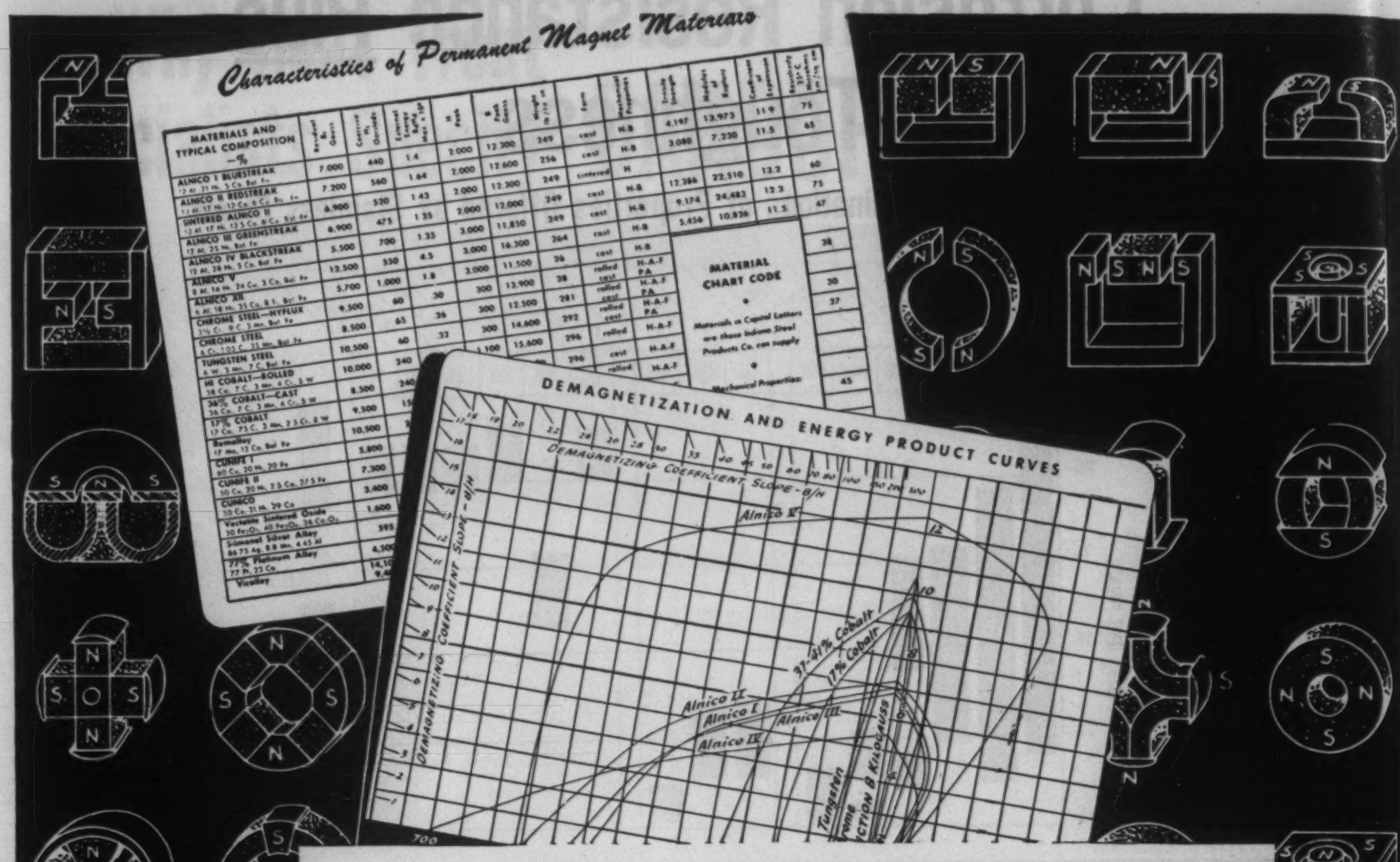
RUSTLESS IRON AND STEEL DIVISION

The American Rolling Mill Company

BALTIMORE 13, MARYLAND

SALES OFFICES AND DISTRIBUTORS IN PRINCIPAL CITIES

PERMANENT MAGNETS MAY DO IT BETTER



Helpful Reference Data for Use of "PACKAGED ENERGY"

Of special interest to engineers and product designers—here are two helpful reference charts, shown in reduced size above, on the *energy product* and *physical characteristics* of permanent magnets featured in the latest "Permanent Magnet Manual", prepared by *Indiana Steel Products Company.*

This manual contains valuable technical data on uses and applications of permanent magnets; modern materials and methods of fabrication—including complete information on the facilities of the Indiana Steel Products Co., the world's largest producer of "Packaged Energy". Ready for prompt mailing to any firm or individual considering commercial magnet application, this manual is available without cost.

More than 24,000 applications of "Packaged Energy" have been developed by our engineers. They are intimately acquainted with all grades of permanent magnet materials and problems of design and application. You are invited to consult with them without obligation.

Write for your free copy of "Permanent Magnet Manual No. 3" today!

***Producers of* Packaged Energy**

★ ★ ★ **THE INDIANA STEEL PRODUCTS COMPANY** ★ ★ ★

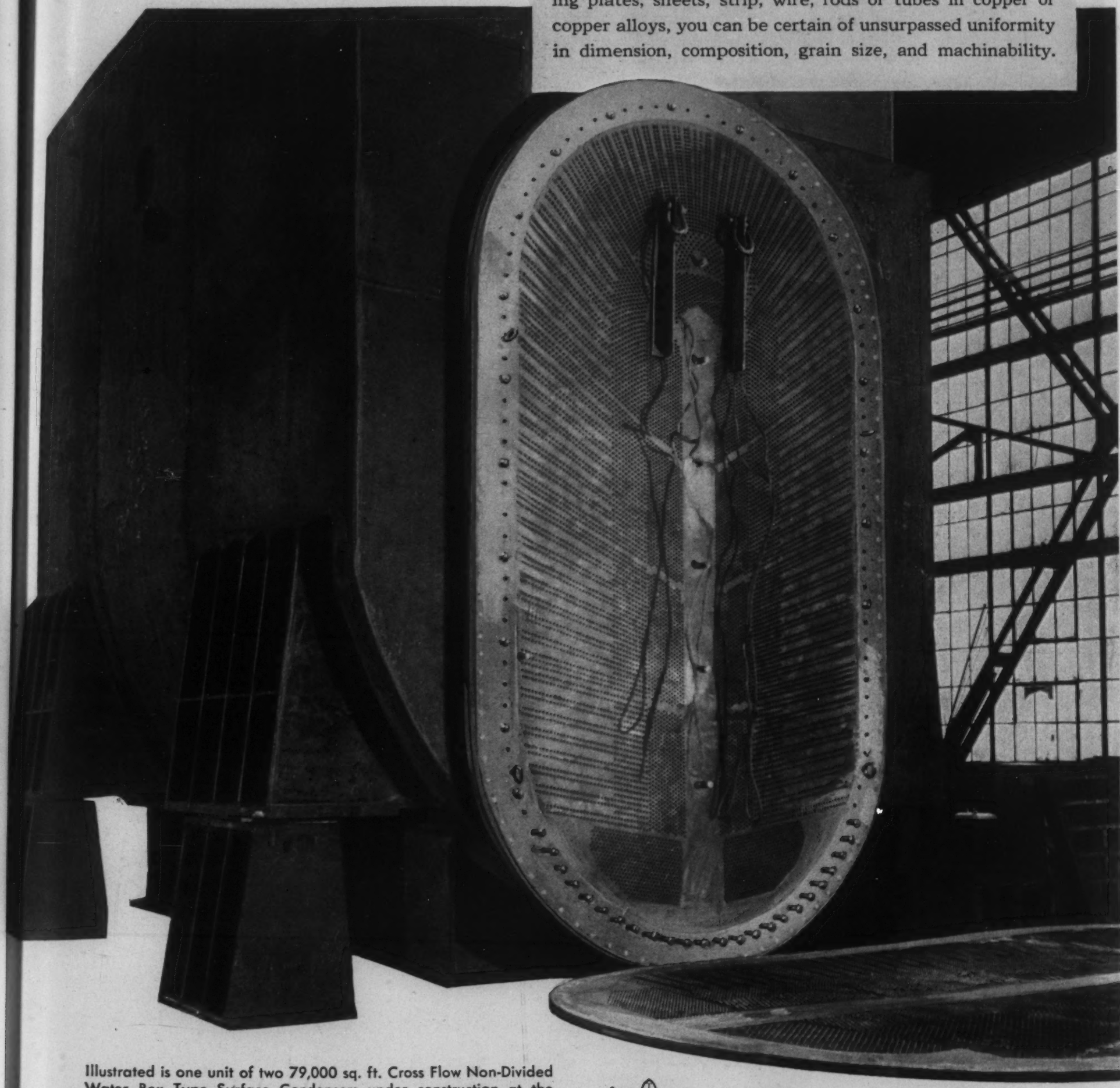
6 NORTH MICHIGAN AVENUE, CHICAGO, 2 ILLINOIS

Copr. 1948, The Indiana Steel Products Co.

SPECIALISTS IN PERMANENT MAGNETS SINCE 1910

An unusual job, these 14,000-pound Anaconda Muntz Metal Plates

But . . . you can expect the unusual in brass mill performance and technical cooperation from The American Brass Company. Furthermore, by specifying "Anaconda" when ordering plates, sheets, strip, wire, rods or tubes in copper or copper alloys, you can be certain of unsurpassed uniformity in dimension, composition, grain size, and machinability.



Illustrated is one unit of two 79,000 sq. ft. Cross Flow Non-Divided Water Box Type Surface Condensers under construction at the Carteret, N. J. Plant of the Foster Wheeler Corporation for installation at the Southwark Electric Generating Station of the Philadelphia Electric Co. The 1-1/2"-thick Anaconda Muntz Metal Tube Plates, measuring 11'7" x 21'1" and weighing approximately 14,000 pounds each, were supplied by the Detroit Branch of The American Brass Company. 12,316—27/32" tube holes and 108—1-5/8" bolt holes were drilled in each plate. See the following page.

ANACONDA

Anaconda

COPPER & COPPER ALLOYS

THE AMERICAN BRASS COMPANY

General Offices: Waterbury 88, Connecticut

talking about the machinability of Brass...

Depth of hole, 3″

Drill Size, 27/32″

Speed, 2200 r.p.m.

Feed, .015″

Drilling Time

6 SECONDS!

See the preceding page for a description of these 14,000-pound Anaconda Muntz Metal (60% copper – 39.5% zinc – 0.5% lead) Condenser Tube Plates. The photo below was taken in the shops of Foster Wheeler Corporation.

The 1-1/2″-thick plates were clamped together for drilling 12,316–27/32″ matched tube holes. Yet, so uniform was the metal in machinability that hole after hole—in all parts of the 11′7″ x 21′1″ plates—was drilled in 6 seconds. 46159

ANACONDA
from mine to consumer

Anaconda

COPPER & COPPER ALLOYS

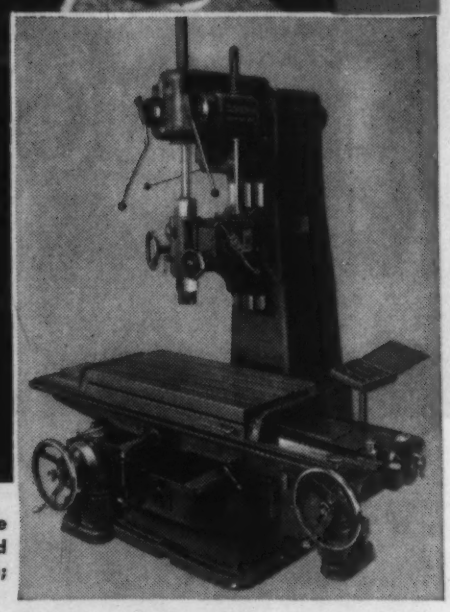
THE AMERICAN BRASS COMPANY

General Offices: Waterbury 88, Connecticut

Subsidiary of Anaconda Copper Mining Company

In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

A Better Gear AT 82% LOWER COST WITH Electronic HEATING



In a matter of seconds the teeth alone are heated to hardening temperature and then quenched. Only the teeth are hardened, and distortion is minimized —speeding production of Cleereman jig borers (inset). G-E heaters are flexible; various jobs can be handled simply by changing the heating fixture.

G-E Electronic Heaters are making it possible for the Cleereman Machine Tool Co. of Green Bay, Wisconsin to heat-treat and finish gear and clutch assemblies at 1/5 the former cost —and get *better* gears in the bargain!

Describing this amazing cost reduction, Cleereman's Chief Engineer states: "To arrive at our savings, we have considered the change in operations which permits us to finish-broach the bore of the gears before cutting and hardening—which *eliminates* the need of *grinding* the bore. In addition, we are getting a *more accurate gear.*"

Heat-treating and finishing costs were reduced from $2.05 to $0.35 per unit, thanks to the elimination of the grinding operation and a material reduction in the cost of heat-treating.

Electronic induction heating has solved many production problems involving the application of heat to sharply defined areas, treatment requiring rapid heating, and the brazing or soldering of small or complex assemblies. General Electric also has a complete line of electric furnaces for all types of heat treating, as well as small unit heating devices. Our heating specialists will gladly submit unbiased recommendations on the type of electric heating equipment best suited to your job. *General Electric Company, Schenectady 5, N. Y.*

ELECTRONIC HEATERS

GENERAL ELECTRIC

675-130-8744

A Good Steel to Use for

INDUCTION OR FLAME

Hardening

Part fabricated from Cold Drawn C-1144, The largest diameter is induction hardened.

Machined from Cold Drawn C-1144 . . . and flame hardened on interior surfaces.

C-1144 is a modern steel for modern uses . . . a free-machining Open-Hearth grade that is sulphurized to provide the extra machinability needed in the high-speed production of parts where given strength or hardness is required.

C-1144 is a heat treating grade of high carbon steel. In addition to being suitable for regular heat treatment, it is especially adapted for use in fabricating parts to be induction or flame hardened.

This free-machining Open-Hearth Steel may be the answer to your production problem. Why not look into its advantages? B&L field service engineers will be glad to give you further details on request.

BLISS & LAUGHLIN, INC.

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Sales Offices in all Principal Cities

COLD FINISHED STEEL AND SHAFTING

Telltale LINES

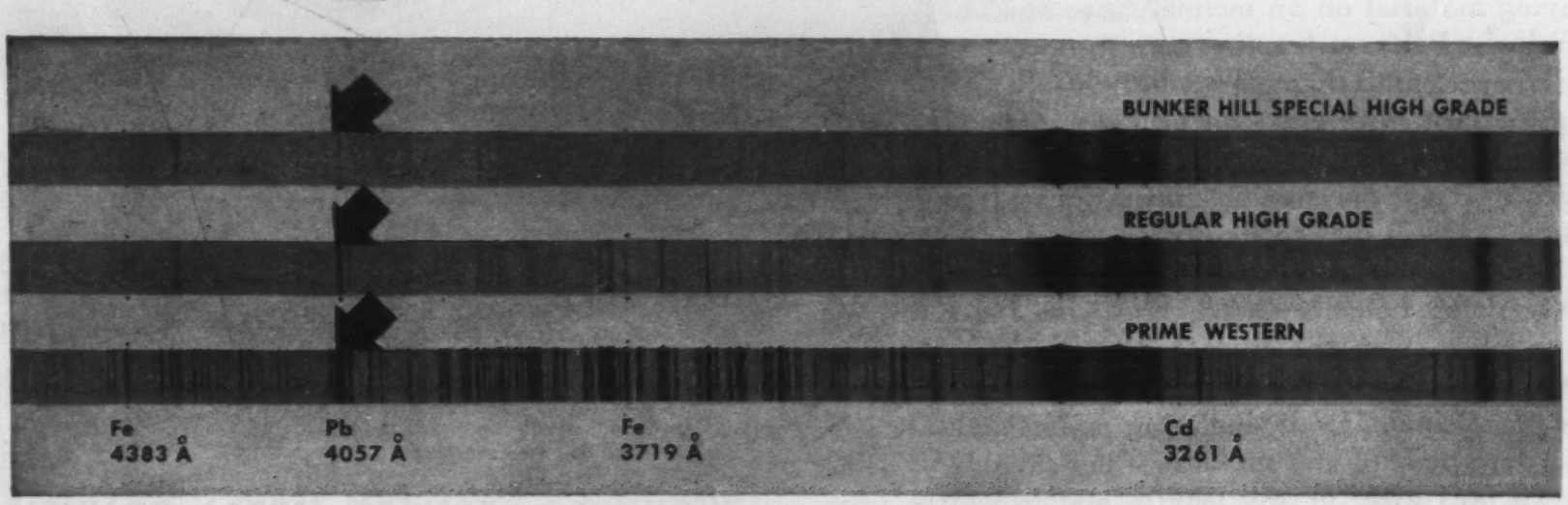
Lines of the Spectrograph! Photographic evidence of the presence of elements in a body heated to luminescence! Infallible in their disclosures, spectral lines have led to some important discoveries, particularly of new elements. For example, in 1866 Janssen noted in the spectrum of the sun a certain line not present in any other spectrum known and studied up to that time. Evidently a new element, it was appropriately named Helium from the Greek word for sun, Helos. Later, by means of this specific spectral line, Helium was identified as a component part of some natural gases.

Today, spectroscopy is an exact science. The metallurgist constantly uses the spectrograph in his study of metals and alloys. From the location of the "element" lines in any given spectrum he can just tell what elements are present. From the density of the lines, he can accurately determine the quantities. He can compare amounts in similar products.

Spectral lines indeed are "telltale lines"! Note, for example, the lines in the spectrograph of three different grades of zinc now on the market. *Note particularly the "lead" line of Bunker Hill Special. It's just a hairline, hardly visible!* It tells the story of an exceptionally low lead content in a zinc running consistently 99.99+ % pure.

•

DIE CASTING is the Process . . . ZINC, the Metal . . . BUNKER HILL, the Preferred Zinc



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BUNKER HILL 99.99+% ZINC

6-SJ-4

Wickwire belts are built to beat *TOUGH* problems

Photograph Courtesy of Link-Belt Co., Chicago, Ill.

Whether your belt problem involves freezing or brazing temperatures; light or heavy loads; resistance to corrosion or abrasion, Wickwire Spencer will custom-engineer a belt to beat the problem.

Take the example at the right. This quenching process shows an efficient application of a chain driven Conventional Weave Belt with Angle Flexlift for conveying material on an incline. Note how Wickwire Belt construction permits operation over small diameter pulleys insuring extreme flexibility and economy of design. Open weave construction facilitates drainage for washing operations and free air circulation for drying.

The long, dependable service and cost-cutting benefits which Wickwire Belts provide have made them the accepted standard for the heat treatment of metals, glass and ceramic ware and for the processing of foods, chemicals and other materials. Belts are built of any metal or alloy capable of being drawn into wire; in any length, and in widths from 1" to 192".

If you have a conveyor belt problem our engineers will be happy to cooperate in its solution. Send for our illustrated catalog showing types and advantages of numerous conveyor belt constructions. Address Mechanical Specialties Department, Wickwire Spencer Steel, Sterling St., Clinton, Mass.

WICKWIRE SPENCER METAL CONVEYOR BELTS ARE BEING USED IN

Annealing Ovens	Canning
Baking Ovens	Dehydrating Food
Brazing Furnaces	Degreasing
Chemical Processing	Frozen Foods
Decorating Glass	Hardening Furnaces
Ceramic Products	Infra-Red Drying

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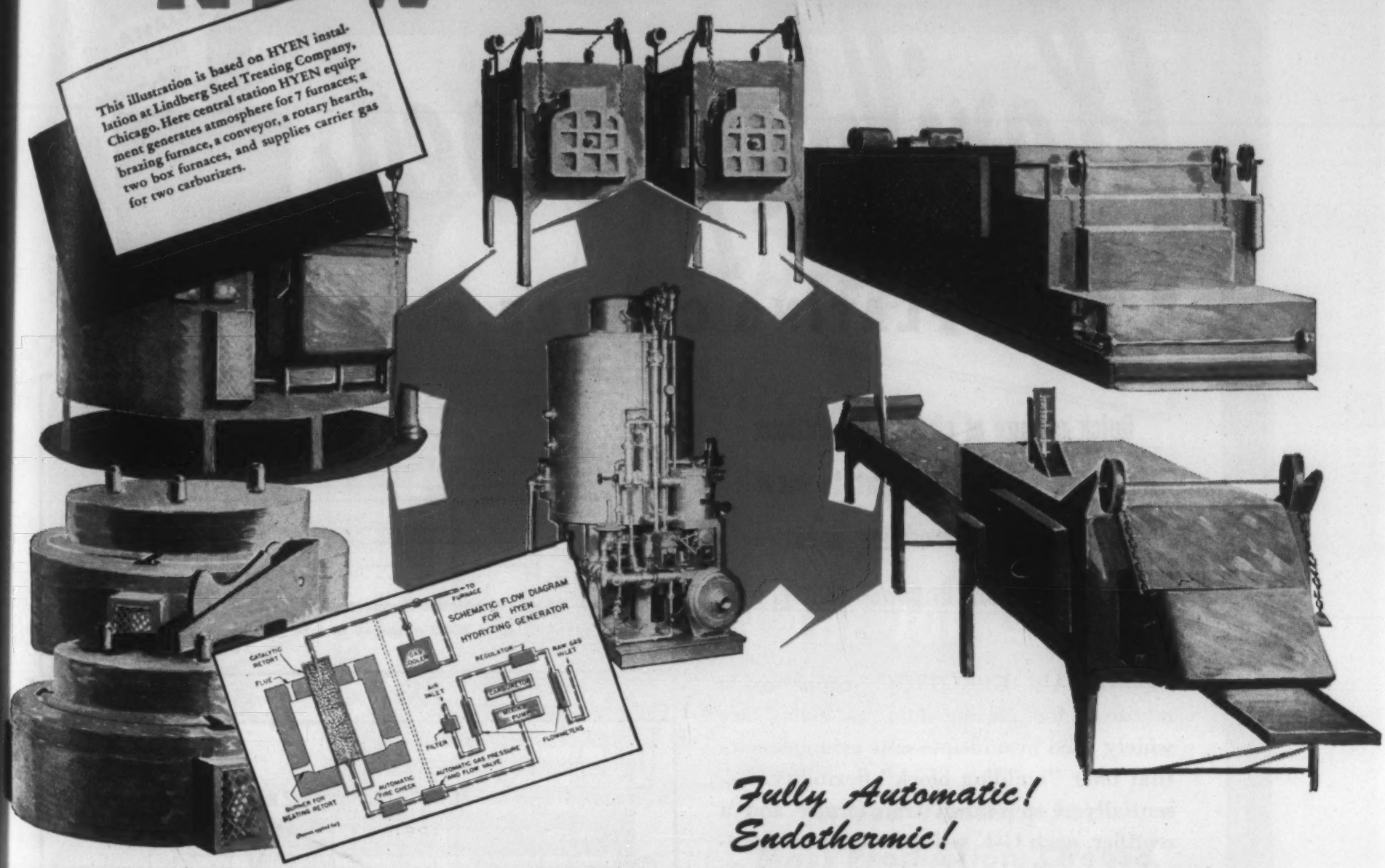
NOW

The New Lindberg "HYEN"

A CENTRAL STATION ATMOSPHERE GENERATOR TO SERVE A NUMBER OF FURNACES . . . . . .

This illustration is based on HYEN installation at Lindberg Steel Treating Company, Chicago. Here central station HYEN equipment generates atmosphere for 7 furnaces; a brazing furnace, a conveyor, a rotary hearth, two box furnaces, and supplies carrier gas for two carburizers.



Fully Automatic!
Endothermic!

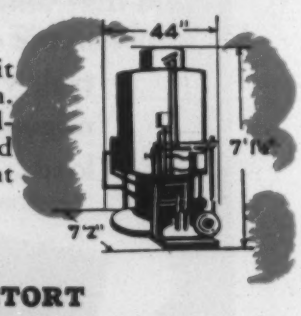
For Hardening - Brazing - Sintering all medium and high carbon steels without decarburization!

The new HYEN is a central station generator that furnishes atmosphere for a number of furnaces. Like your air compressor, or electric generator, it's fully automatic —can be installed in an out-of-the-way location, and forgotten. It requires no charcoal, and does not have to be burned out periodically to remove soot.

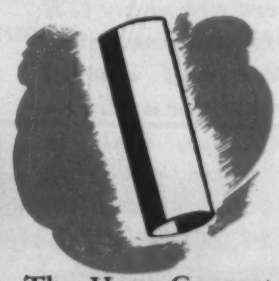
The HYEN produces a cleaner and drier gas of consistent analysis—no CO_2, minus 10°F dew point, methane 1.0%. Three and a half years of rigorous operation —both in the research laboratory and on the production line, have proved without question that the HYEN easily does a precise job, simply, and with consistent results.

FULLY AUTOMATIC
Light the pilot, and from then on every phase of the generator is automatically controlled through push-buttons. Temperature, mixing, pressure and flow control are fully automatic. Gas ratios do not have to be readjusted when furnaces are cut in or out of the line.

SAVES SPACE
The Hyen saves floor space—1500 CFH unit requires floor area of only 4 ft. by 7 ft. 2 in. Overall height only 7 ft. 1½ in. Four standard sizes available—500, 750, 1500, and 2500 CFH. Can be used with your present atmosphere furnace.



NO SOOTING
Time is saved and production increased because high temperature cracking eliminates sooting. Thus, periodic cleaning and burnout periods are not required.



REFRACTORY RETORT
Higher cracking temperature than ever before possible because a new type refractory retort is used. Result is cleaner and drier atmosphere—No CO_2—Minus 10°F dewpoint—methane 1.0%.

ATMOSPHERE FOR ALL STEELS
The Hyen can be simply adjusted to produce gas in equilibrium with any steel from 0.05 to 2.0% carbon content. When a single generator is used for a group of furnaces running tool and production medium and high carbon steels as in the example above, the generator gas is set to be in equilibrium with approximately 1.0 to 1.50% carbon content steel.

GAS OPERATED
The Hyen Generator operates on city gas, natural, propane or butane. It is an endothermic catalytic cracking type—uses only gas for both atmosphere and heating.

LINDBERG ENGINEERING CO.
2451 West Hubbard Street, Chicago 12, Illinois

The HYEN derives its name from HYdryzing and ENdothermic, and is one of the Lindberg line of four Hydryzing atmosphere generators. The others are HYEX (EXothermic cracking), HYAM (AMmonia dissociation), and HYCO (high carbon monoxide).

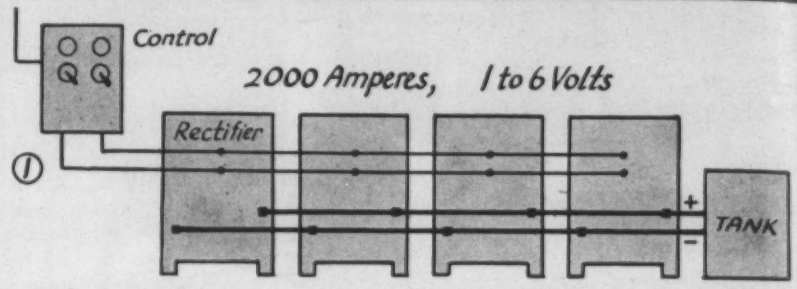
Write for the new 12 *page Bulletin No.* 190, *"Lindberg Controlled Atmospheres."*

LINDBERG FURNACES

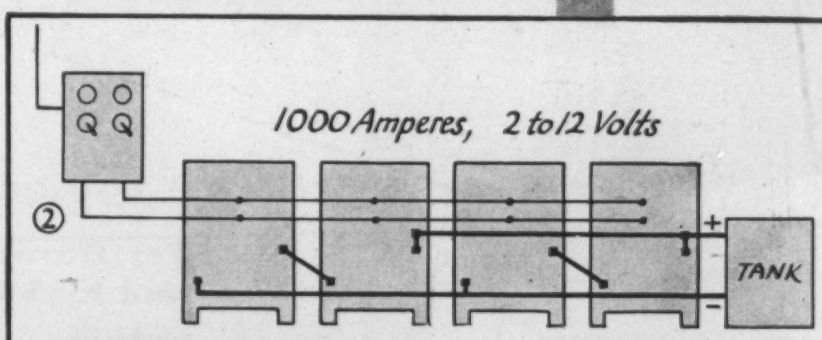
flexible power

FOR PLATING CHANGE-OVER!

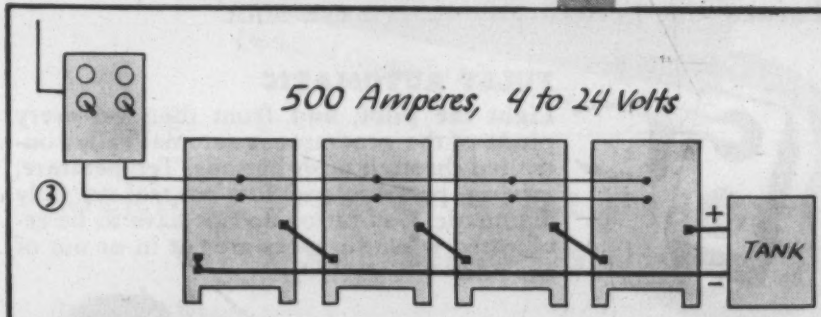
Quick change of circuit connections permits choice of output to meet varying plating, anodizing needs—cuts investment in power supply.



6-VOLT TANK PLATING. Connected in parallel, four G-E copper-oxide rectifiers give 2000 amperes at 1 to 6 volts.



12-VOLT BARREL PLATING: Re-arranged in series-parallel, the units give 1000 amperes at 2 to 12 volts.



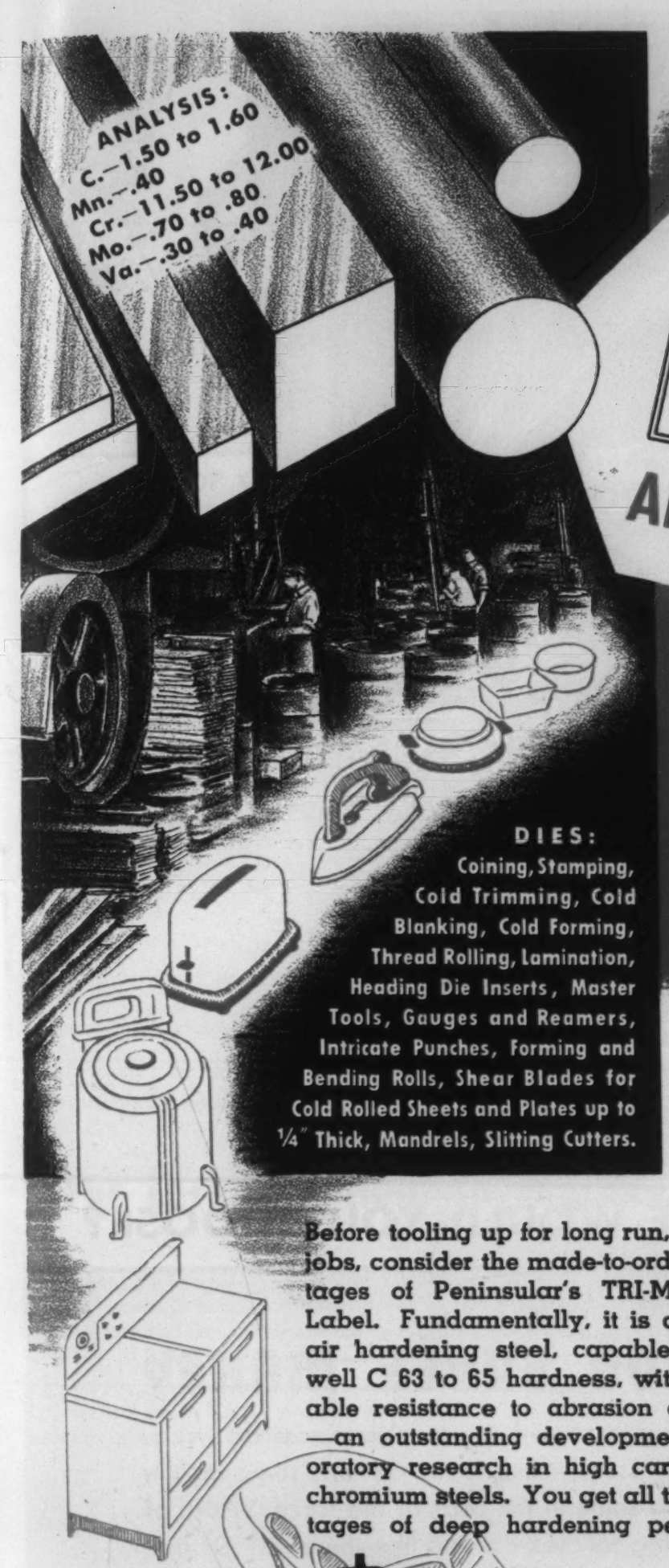
ANODIZING. The same four rectifiers reconnected in series for anodizing that requires 500 amperes at 4 to 24 volts.

GENERAL ELECTRIC copper-oxide rectifiers for plating and anodizing are widely used in multiple-unit arrangements that offer "building block" flexibility. Essentially a step-down transformer and a rectifier, each G-E self-contained unit provides smooth, steady direct current in blocks of 6 or 12 volts.

Output voltage of a single unit, or of a multiple-unit group, is accurately controlled on the a-c input side by G-E rectifier control. By substituting this "on load" control for tank rheostats, important power savings are realized. Control can be automatic or manual. With G-E automatic control, voltage is maintained within plus or minus two per cent, from no load to full load.

There are many G-E plating and anodizing rectifier and control combinations of different ratings, built to meet your exacting needs. For illustrated booklet and full information, write Section A664-143, General Electric Company, Appliance and Merchandise Department, Bridgeport, Connecticut.

GENERAL ELECTRIC



DIES: Coining, Stamping, Cold Trimming, Cold Blanking, Cold Forming, Thread Rolling, Lamination, Heading Die Inserts, Master Tools, Gauges and Reamers, Intricate Punches, Forming and Bending Rolls, Shear Blades for Cold Rolled Sheets and Plates up to ¼" Thick, Mandrels, Slitting Cutters.

Peninsular's

TRI-MO
WHITE LABEL
Air Hardening Tool Steel

STAYS ON THE JOB *Longer*

When Tooling for Mass Production, Choose TRI-MO WHITE LABEL for Enduring Accuracy

Before tooling up for long run, precision jobs, consider the made-to-order advantages of Peninsular's TRI-MO White Label. Fundamentally, it is a superior air hardening steel, capable of Rockwell C 63 to 65 hardness, with remarkable resistance to abrasion and wear—an outstanding development of laboratory research in high carbon, high chromium steels. You get all the advantages of deep hardening penetration, with its non-sinking, non-deforming properties which permit numerous regrinds and continuous hard usage without loss of efficiency. Order TRI-MO White Label now from Peninsular's available supply.

SIZES NOW IN STOCK

Flats—¼ to 12 inches wide
Rounds—¼ to 10 inches in diameter
Squares—¼ to 4 inches
Forging Billets—4 to 10 inches square

The PENINSULAR STEEL Co.

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WHICH ONE WOULD YOU CHOOSE?

COMFORT TOO SAVES MONEY

Give your burner a cutting torch with the maximum comfort value. Some prefer the high pressure valve lever on top, some on the bottom, some in front and some in the rear of the torch. Which of these VICTOR hand cutting torches do you like the best? Of one thing you can be sure—no matter what the choice, VICTOR cutting torches are designed for maximum operating speed and minimum ownership cost.

VICTOR

VICTOR EQUIPMENT COMPANY

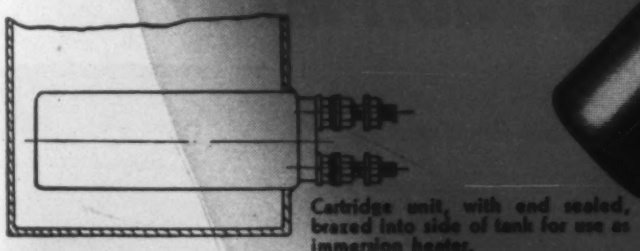
844 FOLSOM ST. • SAN FRANCISCO 7, CALIFORNIA

Ad 134

Chromy Says: "The Right HEAT for Your Job!"

Chromalox *Electric* Cartridge Heaters

EASY TO INSTALL—Cartridge Heaters fit into holes drilled in platen. Thermostat may be applied in same manner.



Cartridge unit, with end sealed, brazed into side of tank for use as immersion heater.

For Localized Heat in Processing Equipment!

Compact CHROMALOX *Electric* Cartridge Heaters are efficiently doing hundreds of industrial heating jobs. They are easily installed in dies, platens, molds, process machinery, etc. where concentrated heat is needed . . . or can be used as permanent or portable immersion heaters in liquid solutions.

If you use heat in manufacturing your product, CHROMALOX Electric Heaters can save you time and money and improve your product. Let us know your heating problem and work with you on its solution, using fast, dependable, economical CHROMALOX *Electric* Heaters.

These users of

CHROMALOX

Electric Heaters

say:

Factory Manager—
Plastics Plant:

". . . due to economy of operation, very accurate temperature control, absolute cleanliness and freedom from humidity, we would not change to any other heating method."

General Manager—
Railroad Equipment
Manufacturer

"By baking cores electrically, we can obtain high quality cores for making refined castings in alloy metals. We are pleased with our investment in this equipment."

Manager—
Electroplating Department

"Experience in production has demonstrated the advantages of electric heat—advantages which led to our decision to establish a new all-electric plant for cadmium and chromium electroplating."

CHROMALOX

Electric Heat for Modern Industry

IC-19

"Want Application Ideas?"

Write for illustrated booklet "100 Ways to Apply Electric Heat," Catalog 42 and the address of the Chromalox Application Engineer serving you.

EDWIN L. WIEGAND COMPANY, 1523 Thomas Boulevard, Pittsburgh, Pa.

TESTING MACHINES NEED

Calibrating?

Here's a BALDWIN SERVICE to help you . . .

How long since you have had your testing machine calibrated? You'll probably find that a check-up is a good investment.

The Baldwin Calibration Service places at your disposal the help of a specially trained engineering staff, and the largest assortment of Morehouse Proving Rings in the country.

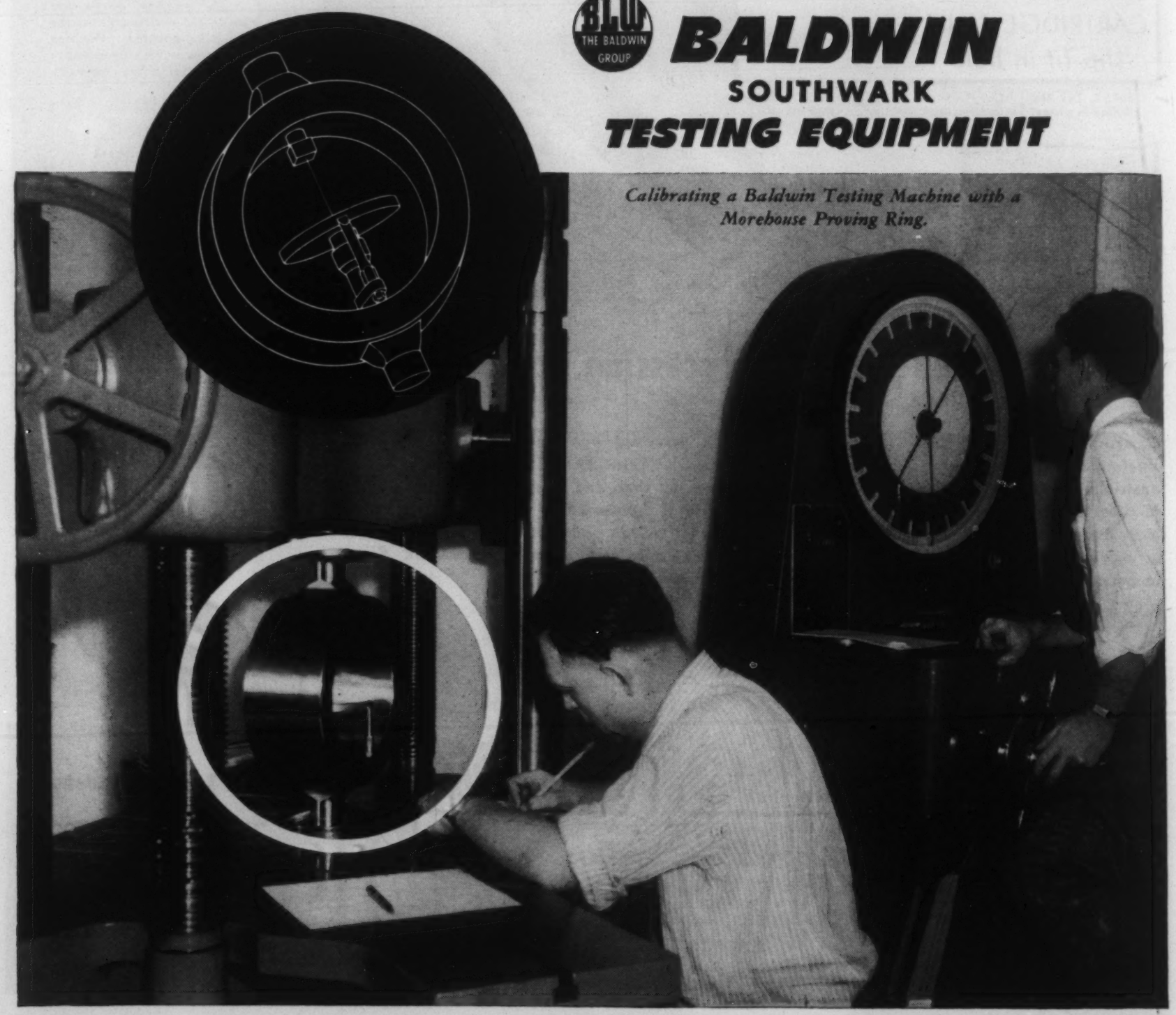
The service can also be used to check scales, measure reactions, and determine loadings in structures and equipment.

Bulletin 186 will give you added information. Write for a copy.

The Baldwin Locomotive Works, Locomotive and Southwark Division, Philadelphia 42, Pa., U. S. A. Offices: Philadelphia, New York, Chicago, St. Louis, Washington, Boston, San Francisco, Cleveland, Detroit, Pittsburgh, Houston, Birmingham, Norfolk.

BLW THE BALDWIN GROUP

BALDWIN
SOUTHWARK
TESTING EQUIPMENT



Calibrating a Baldwin Testing Machine with a Morehouse Proving Ring.

PLASTICS MAKE A MAGIC LENS

Our airmen needed eye protection for high altitude flying—a new heated lens that wouldn't frost, even at 50 below zero.

The problem of heating a goggle lens was brought to the Appliance and Merchandise Department of General Electric. G-E engineers at 1 Plastics Avenue showed how to laminate transparent, heat-conducting plastics to contain an electrical heating element—a vein of fine wire.

G. E. developed a novel, precise process to laminate a perfectly flat, optically true lens with its fine wire heating element intact. Dust and fingerprint flaws were avoided by air-conditioning and by clothing operators in lintless uniforms and gloves. More than half a million heated plastics goggle lenses were made for our flyers by General Electric.

Many other wartime jobs have added to plastics "know-how" at G. E.—the world's largest manufacturer of finished plastics products. Bring any plastics problem to the General Electric Co., 1 Plastics Avenue, Pittsfield, Mass. *We shall be glad to send you upon request a copy of the new illustrated booklet, "What Are Plastics?"*

EVERYTHING IN *Plastics*

G-E Complete Service—Everything in Plastics

Backed by 52 years of experience. We've been designing and manufacturing plastics products ever since 1894. G-E Research works continually to develop new materials, new processes, new applications.

No. 1 Plastics Avenue—complete plastics service—engineering, design and mold-making. Our own industrial designers and engineers, working together, create plastics parts that are both scientifically sound and good-looking. Our own toolrooms are manned by skilled craftsmen—average precision mold experience, 12 years.

All types of plastics. Facilities for compression, injection, transfer and cold molding . . . for both high and low pressure laminating . . . for fabricating. And G-E Quality Control—a byword in industry—means as many as 160 inspections and analyses for a single plastic part.

GENERAL ELECTRIC

CD46-A12

General Electric plastics factories are located in Fort Wayne, Ind., Meriden, Conn., Scranton, Pa., Taunton, West Lynn, and Pittsfield, Mass.

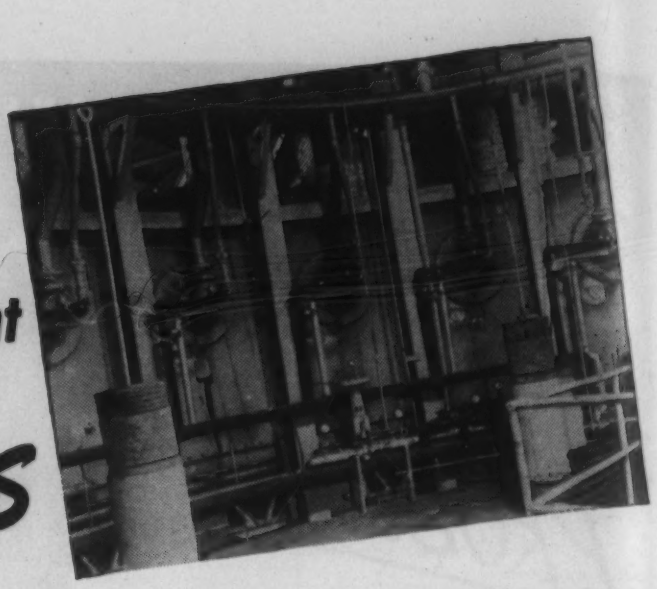
World's largest rotary furnace

AT

The Timken Roller Bearing Company plant

CANTON, OHIO

proves adaptability of GAS



An outstanding example of adaptability of Gas and Gas equipment in successfully solving any industrial heating problem is seen in the world's largest rotary furnace used to heat alloy steel billets for piercing into seamless steel tubing at the Canton, Ohio plant of The Timken Roller Bearing Company.

Here, equipment engineers were called upon to build a furnace for heating round billets up to 10″ in diameter and 12′ in length, which would do the job more economically than existing equipment.

The result is this Gas giant with 2100 sq. ft. of hearth area and a capacity of 80,000 lb. per hour, when heating billets up to 2250 °F. Speed of the hearth ranges from 2 to 8 hours per revolution. Temperature control is fully automatic and a single operator can determine the temperature and location of each billet at any instant during the heating period. Since the start of operations, this Gas furnace has saved an average of 2% in scale loss alone. Maintenance costs are at a minimum and six men per turn were released for other plant duties.

You, too, will find that Gas equipment manufacturers have a rare understanding of your problems and how to solve them. Consult the Industrial Engineer of your local Gas Company, who is your liaison man with the entire Gas Industry.

AMERICAN GAS ASSOCIATION

420 Lexington Ave., New York 17, N. Y.

THE TREND IS TO GAS

FOR ALL INDUSTRIAL HEATING

Find out why
In shop after shop
CIRCLE "C" SUPER HIGH SPEED STEEL
licks the tough jobs!

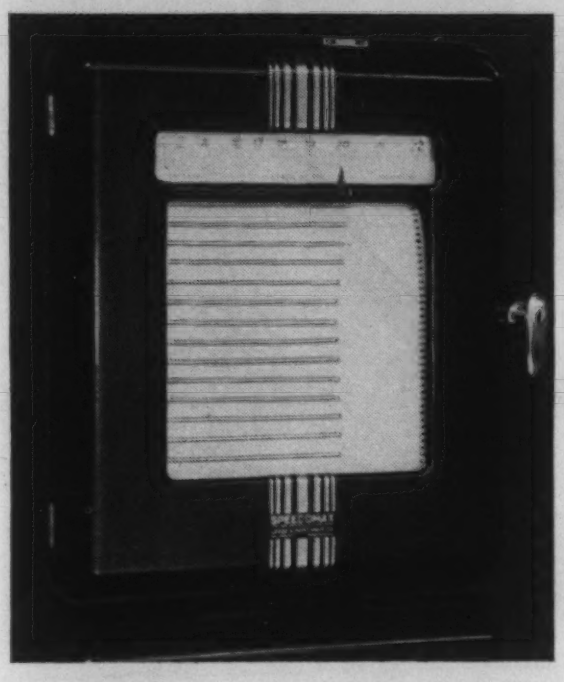
Circle "C" is the out-and-out choice of many for maintaining peak production and limiting "down-time." Write today for full information, or ask for a convincing demonstration in your own shop.

Call **Firth-Sterling**

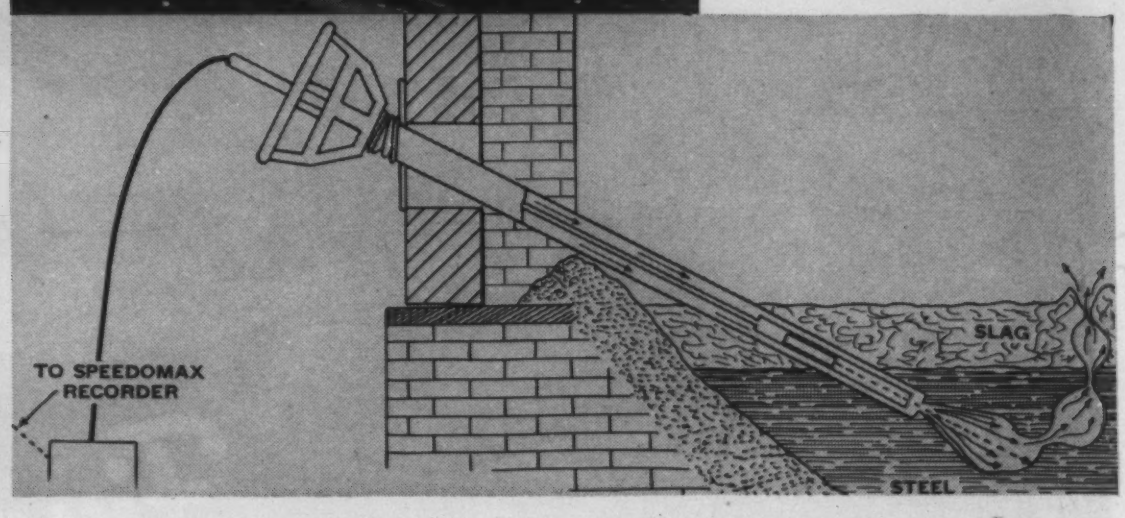
STEEL COMPANY

McKEESPORT, PA. • NEW YORK • HARTFORD • PHILADELPHIA • PITTSBURGH • CLEVELAND • DAYTON • DETROIT • CHICAGO • LOS ANGELES

Operator prepares to plunge Immersion Rayotube into Open-Hearth bath.



Immersion tube in operating position, showing Rayotube sighting directly on hot metal. Speedomax instrument at left instantly records metal temperature.



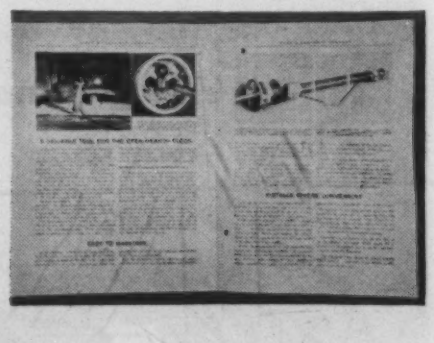
NEW! IMMERSION RAYOTUBE Measures O-H Bath Temperature

A Rayotube which can be thrust through the slag and into the steel bath of an open hearth furnace is now available. It solves the long-time problem of measuring the temperature of molten steel before it leaves the furnace—while the reading can still be used in preparing the heat for tapping.

By giving such timely information, the Immersion Rayotube Pyrometer, as the device is called, makes possible better product and greater operating efficiency in the steel mill.

It may even help to open up a new vista of understanding of the chemistry of steel making, since it gives the metallurgical department permanent records of facts which it will wish to accumulate and study, while both metallurgists and open-hearth operating force can use the information for instant, effective readying of each melt.

Write us for further details. We'll be glad to send this Folder N-33B-643 (1), completely describing the Immersion Rayotube Pyrometer, or an L&N engineer will call, as you prefer.



LEEDS & NORTHRUP COMPANY, 4925 STENTON AVE., PHILA. 44, PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Jrl Ad N-33B-643(4)

AN EDITORIAL

High Temperature Materials

Few wartime materials engineering developments can be compared to the high temperature "super-alloys" program with respect to urgency, importance of the accomplishment, scale of cooperation involved, and significance for the future. Just a few weeks ago technical information about the new alloys developed in this program was "declassified" by the Services, and we are privileged to publish in this issue, starting on page 1557, one of the first (perhaps even *the* first) general reviews of the entire program, with descriptive data on virtually all the alloys developed or involved in it.

Back in 1944 this magazine questionnaired 150 leading engineers, metalworking executives and metallurgists concerning the outstanding wartime achievements in new materials and methods. High up among the first 10 was "the development of special heat resistant steels and alloys and of precision manufacturing methods for turbosupercharger and gas turbine components." Virtually all of the other achievements have been fully described in our pages, but because of "military security" not until now has it been possible adequately to present the story of the new high-temperature materials.

As Mr. Knight's article reveals, a large number of companies, organizations and individuals participated in the project — the National Defense Research Committee, the War Metallurgy Committee, several steel companies, turbo manufacturers, alloy foundries, precision casters, ferro-alloy producers, forging plants, research institutes and laboratories, and so on. Many organizations beside those mentioned in the article contributed to the development in important ways. It was one of the war's most ubiquitous technical problems, and one of its finest examples of inter-organization cooperation.

The program and its results are among the most significant of the happier engineering consequences of the war. Alloys were developed that could resist deformation and corrosion at 1200 to 1600 F and which were adaptable to practical manufacture. Because of them we were able to mass-produce high-flying, hard-hitting warplanes and to develop naval power equipment capable of overwhelming our ex-enemies. But beyond that the possible efficiency of both gas and steam turbines has been enormously improved, while the durability of available materials for steam power equipment, oil-refinery service, furnaces, internal combustion engines and other "peacetime" products has been advanced several levels.

And the end is not yet in sight. Research in the high-temperature materials field is now being vigorously pursued, with the purpose of finding alloys or suitable ceramics that will permit of turbine operating temperatures (and therefore operating efficiencies) much higher than even at present. Although still a long way off, heating and power equipment utilizing atomic energy will nevertheless require even better high-temperature materials than today's best.

We may hail with pride our high-temperature-materials achievement to date, and look hopefully to continuing improvement, and especially to the application of the new materials to purposes more socially useful than those for which they were originally developed.

FRED P. PETERS

NEXT-DOOR service on steel

Quick delivery to your plant or job

ELEVEN Ryerson Steel-Service Plants provide unmatched facilities virtually next door to every steel user in the principal markets of the United States. Though many sizes are missing because of the steel shortage, each plant has large, diversified stocks. Each is backed up by the inventories and facilities of the others. These strategically-located steel stocks plus modern high speed equipment are your assurance that orders will be filled accurately and promptly.

Ryerson metallurgists and engineers provide reliable help in solving problems of selection and fabrication. Questions of heat treatment are answered by the hardenability report sent with each Ryerson alloy shipment.

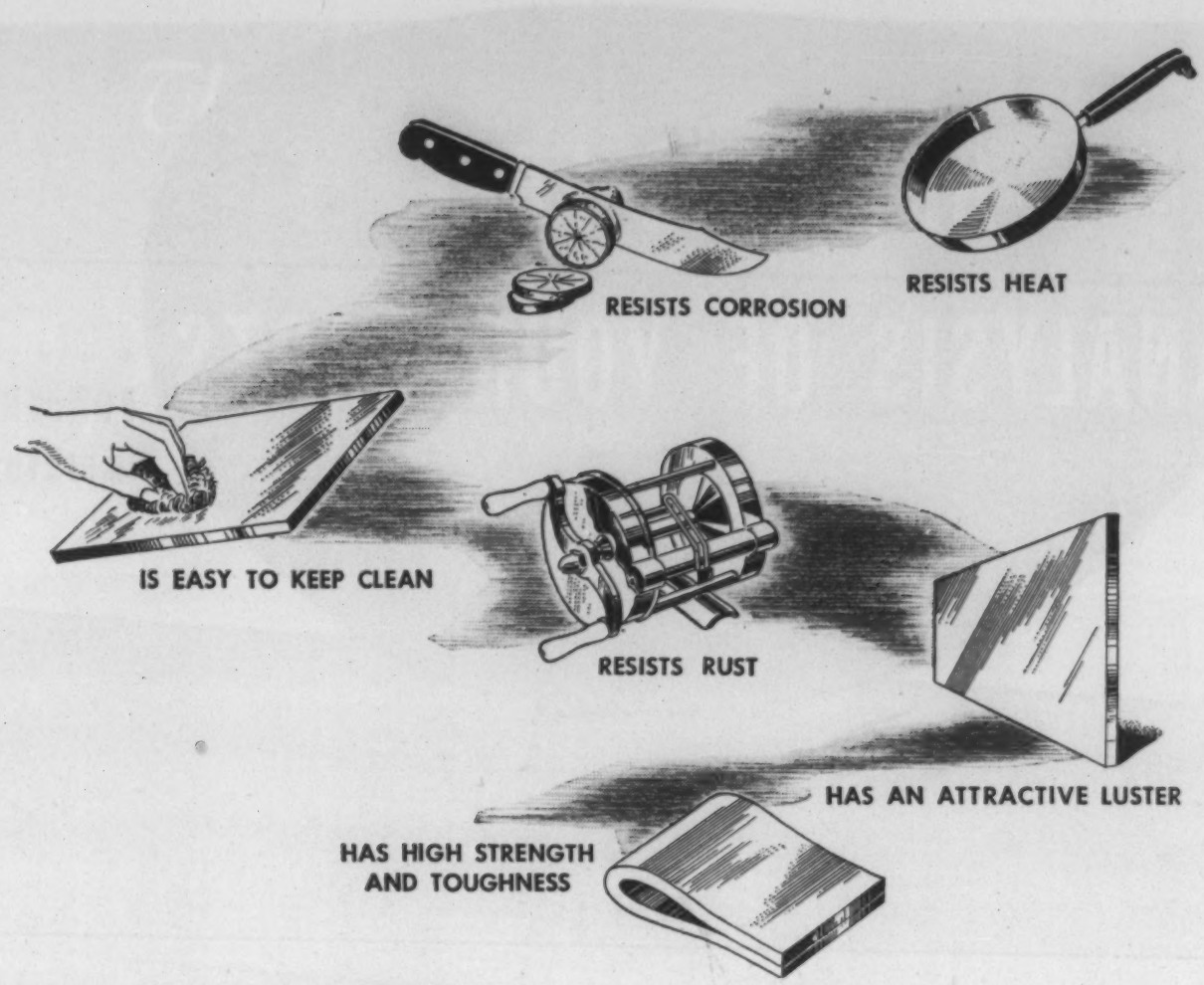
Complete, trouble-saving service on steel from stock is available to you at every plant in the Ryerson network. When you need steel of any kind call Ryerson.

Joseph T. Ryerson & Son, Inc., Steel-Service Plants: Chicago, Milwaukee, St. Louis, Detroit, Cincinnati, Cleveland, Buffalo, Pittsburgh, Philadelphia, New York, Boston.

PRINCIPAL PRODUCTS

Carbon and Alloy Steels, Allegheny Stainless, Tool Steel, Bars, Plates, Sheets, Structurals, Mechanical Tubing, Inland 4-Way Floor Plate, Reinforcing Bars and Accessories, Boiler Tubes, Welding Rod, Babbitt, Bolts, Rivets, Metal Working Tools & Machinery, etc.

RYERSON STEEL



SUPERIOR PROPERTIES

How stainless steel can improve your product

When you are designing a new product that requires any or all of these properties, stainless steel is the answer. Perhaps your problem is corrosion and heat resistance in turbine blades. Or do you need a metal that will be easy to clean for food-processing equipment or one that will retain its gleaming surface for architectural trim? Are you designing for resistance to extreme corrosion in chemical and textile equipment? Now that stainless steel is again available, it can help you to improve your product in many ways.

If you are interested in the newer uses of stainless and other alloy steels, ask to receive the monthly publication, ELECTROMET REVIEW. Or, if you need advice on their production, properties, or fabrication, write our Technical Service Department. We do not make steel, but we do produce the ferro-alloys which are used in its manufacture, and our engineers have accumulated a fund of information on the use of stainless steel in many industries.

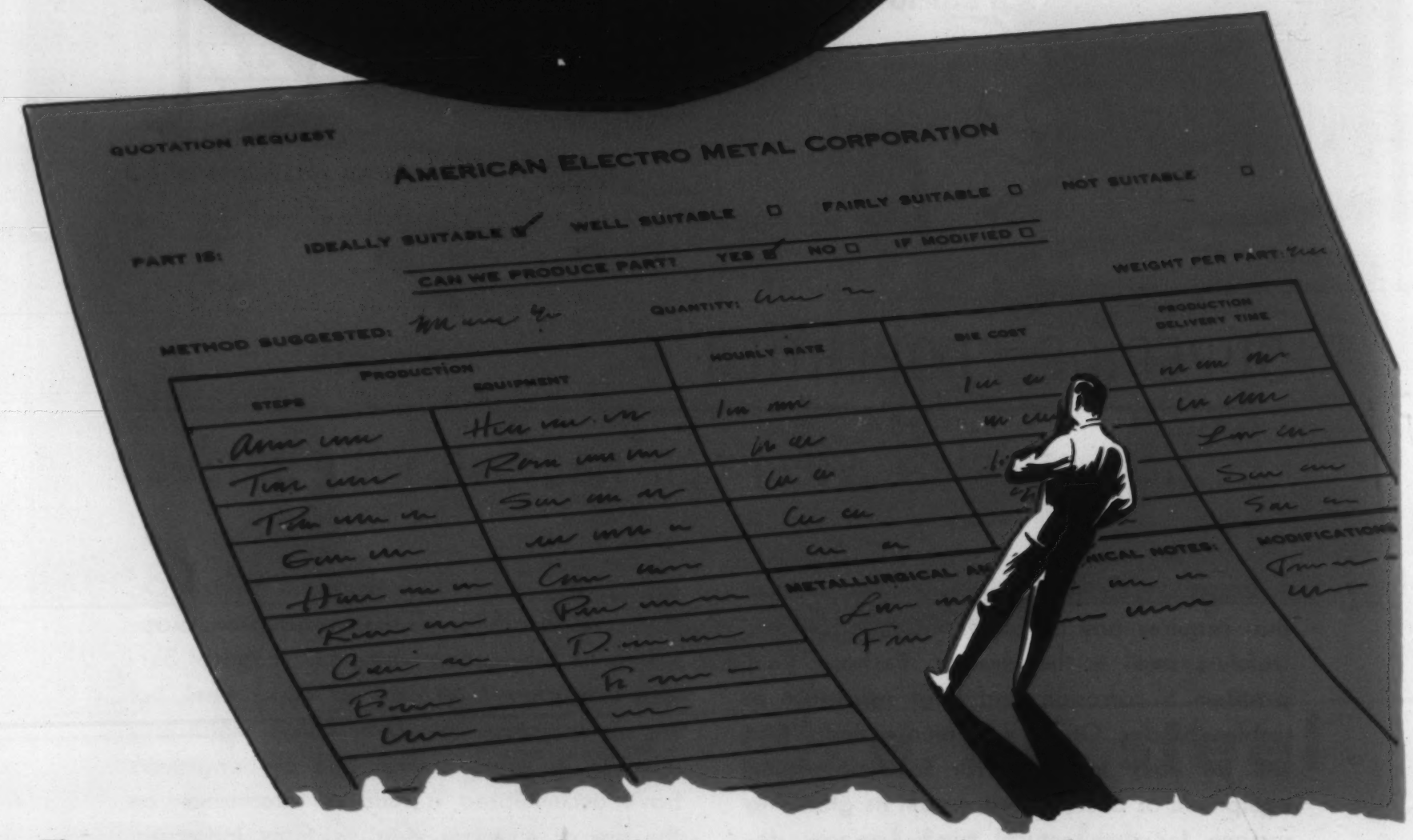
ELECTRO METALLURGICAL COMPANY
Unit of Union Carbide and Carbon Corporation
UCC
30 East 42nd Street, New York 17, N. Y.
In Canada: Electro Metallurgical Company
of Canada, Limited, Welland, Ontario

STAINLESS STEEL

BEAUTIFUL ENDURING STRONG TOUGH

GET THIS FREE ANALYSIS OF YOUR PARTS

. . . to see if SINTEEL POWDER METALLURGY can improve your product



There are so many new SINTEEL materials, with so many new applications, that you owe it to your product to investigate.

And we've set up a special form and procedure to help you do just that. Note its thoroughness.

There are considerations of die cost and design, of porosity (or the lack of it), of impact and tensile strength, of steel analysis and hardenability, of tolerances and moulding direction . . . all to be weighed by specialists before we can tell you whether or not (and to what degree) SINTEEL can benefit *you* and *your product.*

As developers of materials and processes . . . not just producers of pressed-and-sintered pieces . . . we can volunteer more than a simple "It'll cost you so much." In many cases our recommendations for redesign have been the clues to product improvement. The comprehensive nature of our studies is apparent from the form shown above.

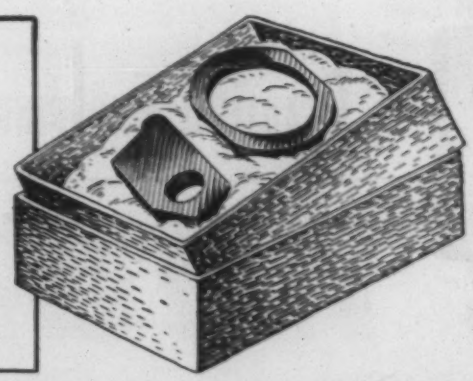
Let our metallurgists, designers and idea-men prepare this thorough analysis for you. Simply send the actual problem parts and prints to us. We will do the rest . . . with no obligation on your part.

JMLco S-FF1

FIND OUT WHERE SINTEEL POWDER METALLURGY FITS IN YOUR PICTURE

SEND 1 prints of the parts you'd like to have us analyze

2 and the actual parts themselves.



AMERICAN ELECTRO METAL CORP.

POWDER METALLURGY FOR MASS PRECISION SINTEEL

Offices in Chicago, Dayton and Detroit

YONKERS 2, NEW YORK

to select the BEARINGS

For the Engineer

A handy file folder containing a wealth of valuable data on Sleeve Type Bearings. Write for your FREE copy.

● The world is waiting anxiously for the new products of American genius. Much has been written about the new materials . . . new methods of manufacturing . . . new finishes that are now available. Never before has the designer had such a golden opportunity to break with the past and to strike out for the future. If the new product contains a motive unit, great care should be exercised in selecting the CORRECT bearings. The RIGHT time to decide what bearing will deliver the greatest performance . . . for the longest time . . . at the lowest cost is *before* production has started. The easiest way to determine this is to call in a Johnson Bronze Engineer. Permit him to review the application . . . to make a recommendation based on facts . . . free from prejudice. Remember, only Johnson Bronze makes EVERY TYPE of Sleeve Bearing. We are ready to serve you NOW!

JOHNSON BRONZE CO.

769 S. MILL STREET NEW CASTLE, PA.

ATLANTA . . . BUFFALO
CAMBRIDGE, MASS.
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CINCINNATI
CLEVELAND
DALLAS
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JOHNSON BRONZE
SLEEVE BEARING HEADQUARTERS

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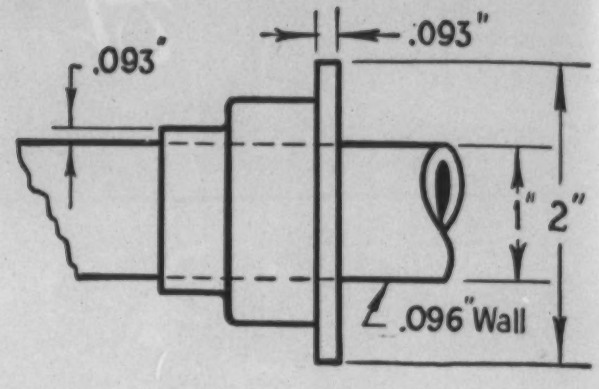
ST. LOUIS . . . . SEATTLE

How "Job-Rating" can improve YOUR designs!



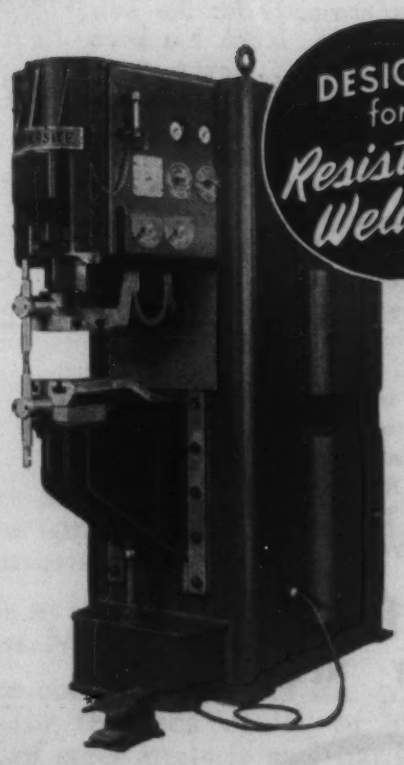
TYPICAL JOB

Assemble and join thin mild steel stampings and tube to resist torque, compression and shear.
No distortion or surface marking permissible on tube.
Total units required—50,000
Production required—1200 per 8-hr. day

JOB-RATING

METHOD	BEST OUTPUT	MAX. STRENGTH	MIN. FINISHING REQUIRED	LOWEST COST PER PIECE
SPOT WELD	1	1	1	1
ARC WELD		2		2
TORCH WELD				
SOLDER (TORCH)			2	
FURNACE BRAZING	2			

List possible joining methods and controlling factors, as above.
Rate the methods 1, 2, for each design factor.
Select the best method. Check your design with this method in mind.



ANALYSIS

Watch resistance welding come up No. 1 on every count! This example shows over 70% savings for spot welding over the second best method, in labor costs alone. In addition, strength is "tops". There is no distortion. Output is far ahead of other methods. Only design factor involved is to make sure there is room on the sleeve for the spot welds. Your analysis may also show similar advantages for resistance welding in a vast majority of assembly problems. 'Progressive' machines, such as the spot welder at left, prove that it pays to weld on job after job. Send for "Welding at Work"—booklet WP-44—describing over 100 different "Progressive-Welded" designs.

IT PAYS TO WELD

PROGRESSIVE Welder Co. 3050 E. OUTER DRIVE • DETROIT 12

RESISTANCE WELDING EQUIPMENT

"Steel is still King!"

Quoted from MATERIALS & METHODS

FOR each application there is usually one best material. It is no mere coincidence that today Steel is the odds-on favorite in virtually every field of manufacture. There are crystal-clear reasons why this is true. . . .

1 ECONOMY

Low cost has always been a fixed characteristic of Steel, not only in the price of the basic material but in the expenditure required to make it into a finished product.

2 VERSATILITY

Only Steel can be produced in such an extreme variety of alloys, forms and finishes. Its characteristics can be tailor-made to fit exactly the demands of the end use . . . high strength-weight ratio, resistance to abrasion, heat, corrosion and fatigue.

3 FABRICABILITY

No other material can be so readily cut, formed, welded, riveted, soldered, machined, stamped and finished.

4 AVAILABILITY

The persistent and far-thinking expansion of Steel's production and distribution facilities makes it today's most abundant manufacturing material.

Have you explored the possibilities of these special purpose U·S·S Steels?

U·S·S STAINLESS AND HEAT-RESISTING STEELS to assure high resistance to corrosion and heat, and to reduce weight.

U·S·S CARILLOY STEELS—Alloy steels for the special jobs of industry.

U·S·S HIGH STRENGTH STEELS to resist atmospheric corrosion and increase strength without adding weight.

U·S·S COPPER STEEL to give at least twice the atmospheric corrosion resistance of regular steel at little additional cost.

U·S·S ABRASION-RESISTING STEEL to combat wear and friction.

U·S·S HOT-ROLLED AND COLD-ROLLED STEELS to provide the basic advantages of steel, plus maximum economy in accordance with the needs of each job.

U·S·S PAINTBOND—A galvanized, Bonderized sheet that permits immediate painting and holds paint tighter.

U·S·S VITRENAMEL—Sheets designed especially for porcelain enameling.

U·S·S ELECTRICAL SHEETS for motors, generators and transformers.

LISTEN to the United States Steel radio show every Sunday evening. Consult your local newspaper for time and station.

USS STEEL — UNITED STATES STEEL

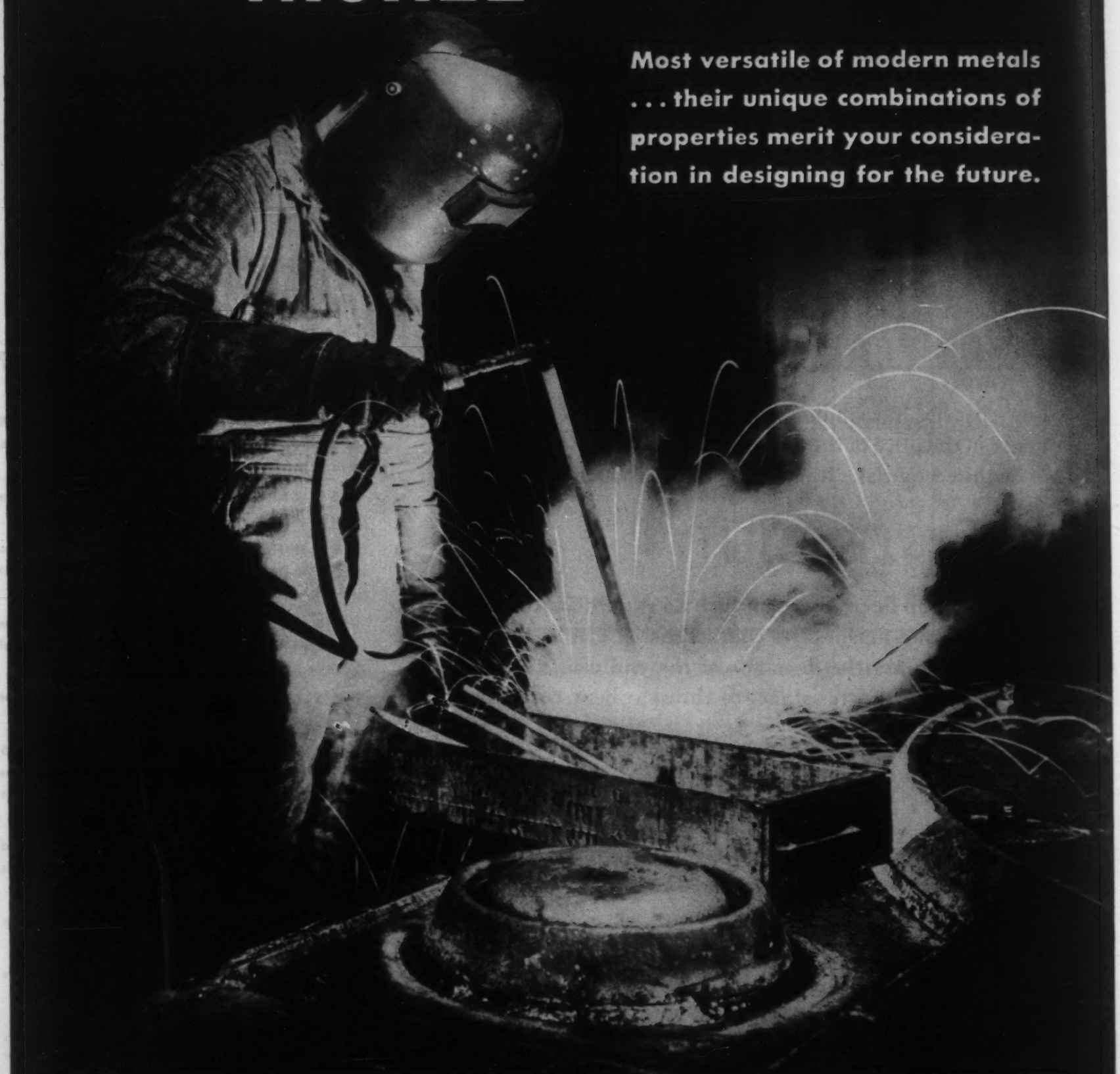
CARNEGIE-ILLINOIS STEEL CORPORATION
Pittsburgh and Chicago

Columbia Steel Company, San Francisco, *Pacific Coast Distributors*
Tennessee Coal, Iron & Railroad Company, Birmingham, *Southern Distributors*
United States Steel Supply Company, Chicago, *Warehouse Distributors*
United States Steel Export Company, New York

UNITED STATES STEEL

CHROMIUM-NICKEL AUSTENITIC STAINLESS STEELS

Most versatile of modern metals . . . their unique combinations of properties merit your consideration in designing for the future.



STAINLESS STEEL ARC WELDING ELECTRODES containing Nickel are used extensively for joining heavy alloy steel plates to avoid brittleness in the weld. Here an operator is using a half inch stainless steel electrode in such a welding operation.

International Nickel are miners, smelters, and refiners of Nickel, an important ingredient in the chromium-Nickel austenitic stainless steels. Although they do not produce these stainless steels, a list of the sources of supply will be furnished on request.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET, NEW YORK 5, N. Y.

CORROSION INFORMATION

. . . available to all

IN working out the design of equipment, engineers can proceed on the basis of well-established and consistent *mechanical* properties of their materials.

However, where corrosive environments are to be encountered in use, an uncertainty often appears as to how these materials will perform. For corrosion resistance is not a *fixed* property — but, rather, one that varies greatly with media and operating conditions.

To help you eliminate—*or minimize*—this uncertainty of selection, The International Nickel Company offers its experience, facilities and accumulated data.

The corrosion engineering research — started by INCO over 38 years ago — has helped put metal selection upon a scientific footing. Laboratory studies, plant tests, outdoor and marine tests have yielded a fund of corrosion data to guide designers and buyers of equipment.

INCO originally undertook this research because one of the principal markets for Nickel is in alloys designed primarily to resist corrosion. Throughout the years, the guiding aim of the program was *to use Nickel Alloys where they belonged . . . and to best advantage.*

Carrying out this aim made it necessary not only to establish what Nickel Alloys could do, but also to discover how they would perform relative to other materials. Guided by this information, INCO's corrosion engineers can make recommendations for Nickel Alloys in specific applications.

INCO corrosion engineering research can be put to work for you in three ways:

By applying to your particular problem the information recorded on over 30,000 corrosion data sheets.

By carrying out specially-developed tests in your own plant.

By undertaking studies of general corrosion problems at INCO *Laboratories and* INCO *Field Test Stations.*

INCO corrosion engineers will make INCO's corrosion information as readily available to you as if it were in your own files.

INCO TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

"I see what you mean— let's buy these light ones"

That's magnesium you've got there, young lady!

That's what makes those field glasses so light . . . so handy . . . so nice to hold and use. Another new and effective application of this lightest metal! They'll be on the market soon—made by one of the many modern manufacturers with whom Dow, as America's leading magnesium producer, cooperates.

You'll be seeing products of many types, made amazingly lighter, of magnesium. And you'll see how quickly people learn to respect magnesium for its strength and dependability, too. Yes, you'll hear it more and more: "I see what you mean —let's buy these *light* ones." And you'll say it, too!

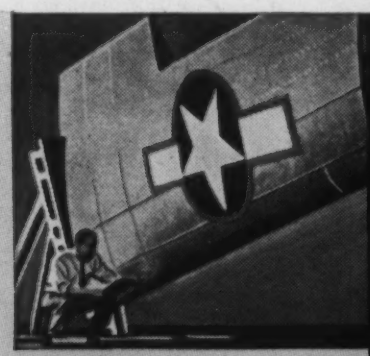
Ready... to make products move!

MAGNESIUM

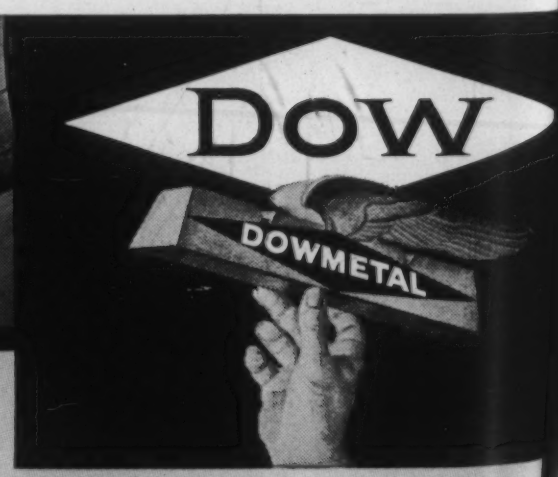
LIGHTEST OF ALL STRUCTURAL METALS

Dow's magnesium production provides manufacturers with a dependable source of this lightest structural metal in all its forms.

Further support to product manufacturers is available from the diversified magnesium fabricators with whom Dow closely cooperates.



Aircraft wings made entirely of magnesium are included in the long list of industrial applications and consumer products now in use.



MAGNESIUM DIVISION • THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN • New York, Boston, Philadelphia, Washington, Cleveland, Detroit, Chicago, St. Louis, Houston, San Francisco, Los Angeles, Seattle

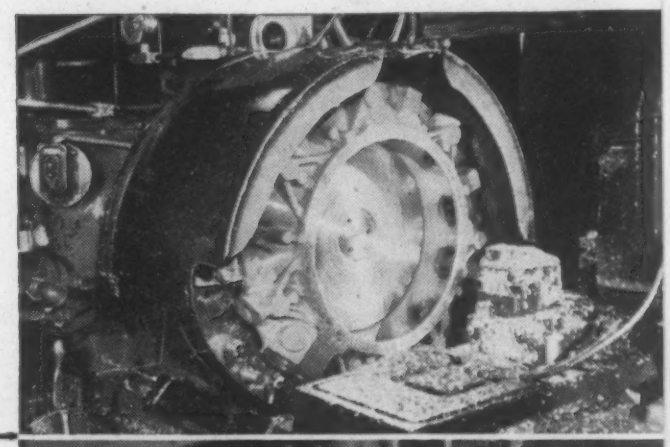
This is a reprint of a Dow magnesium advertisement which appears in full color in national magazines reaching millions of readers in all parts of the country.

Magnesium makes products move

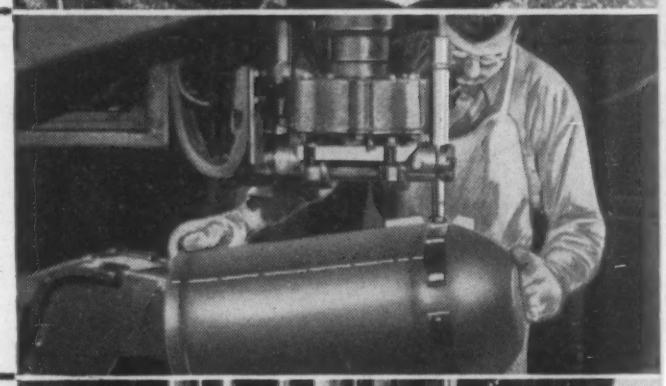
There's fresh new sales appeal for products of magnesium! They have just the kind of modern features everybody looks for nowadays. Magnesium gives them *lightness* unmatched by other common metals . . . a lift that makes them *move* in more ways than one! Yes, magnesium moves merchandise. And in the factory it speeds production, too. Foundrymen, die casters, mill operators, manufacturers—they know magnesium can save them time and labor and power. Easy to handle, easy to work, it's doing just that in many a modern plant. New applications that make the most of magnesium are hitting the market with the combined impact of these advantages . . . in sales . . . in production.

in the store . . . in the shop

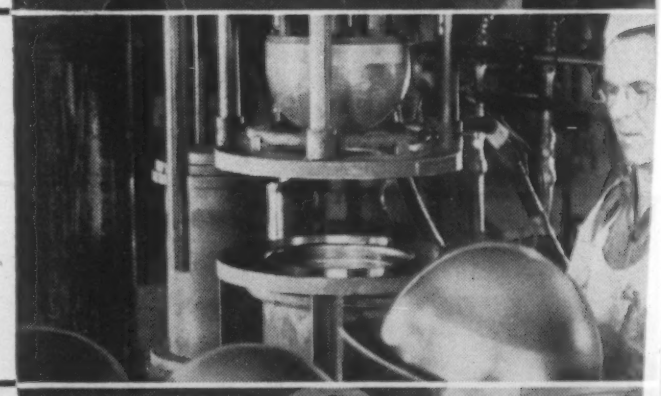
MACHINING MAGNESIUM is commonly done at the maximum speeds of modern machine tools. Magnesium permits heavier depths of cut and higher rates of feed. Cutting tools stand up exceptionally well, too, and there's an additional saving in the power needed to remove a given quantity of magnesium by machining.



WELDING by all common methods is widely used in the manufacture of magnesium products of many types. Modern manufacturers are following well developed processes in joining magnesium by gas, arc, spot, and flash welding. The welding method employed on each specific product is governed by the type of joint and by service considerations.



FORMING operations with magnesium produce deep drawn parts of many kinds. Cylindrical cups, for example, are commonly drawn to a depth of 1½ times their diameter in a single draw by this hot forming method. This reduction in number of draws greatly decreases tool costs and manufacturing time.



HANDLING of parts and products is materially lightened wherever magnesium is used as a production metal. There's a notable lessening of fatigue and a corresponding economy in manpower in many a manufacturing operation with lightweight magnesium. These factors can add up to increased production volume and reduced costs.

MAGNESIUM DIVISION • THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN
New York • Boston • Philadelphia • Washington • Cleveland • Detroit • Chicago • St. Louis
Houston • San Francisco • Los Angeles • Seattle

Wanted

more upset forgings customers

IF you're looking for better service in better forgings, TUBE TURNS is looking for you. With a complete and completely modern assembly of upsetters, including the world's largest—plus proved ability at developing tailor-made procedures for specific jobs—this experienced but young and progressive organization is ready to serve several more customers of the kind who want an extra something when it comes to the mass-production of forgings. Write or call Forgings Development Desk, TUBE TURNS (Inc.), Louisville 1, Ky. Wabash 7551.

TUBE TURNS tt *Forgings for Industry*

Advertisement JUNE, 1946

COPPER ALLOY BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared Each Month by Bridgeport Brass Co. "Bridgeport" BRASS CO. *Headquarters for BRASS, BRONZE and COPPER*

Bridgeport's Technical Service Department

Renders Valuable Assistance To Users Of Brass Mill Products

A basic factor in the solution of many problems confronting the manufacturers of metal products and equipment is the evaluation and selection of suitable materials. The successful operation of an otherwise excellent product may be jeopardized because a vital part is made from a material which under certain conditions of operation is subject to unnecessary failure. Metal specifications must be modernized to meet more severe requirements and possibly new and different manufacturing processes. In many cases it may be difficult for manufacturers to keep abreast of new alloys, improvements in existing ones, new applications for standard alloys and the latest developments in non-ferrous metallurgy and corrosion research. Yet, such information is vital if manufacturers are to make a careful study of materials and methods in their determination to improve quality, modernize production methods, and generally hold their places in the competitive picture.

Technical Service Department Works Closely With Customers

Bridgeport's Technical Service Department, composed of an experienced group of practical men, is helping customers study the possibilities of the newer copper-base engineering alloys as applied to their products. In some cases the solution to metal specification problems may already be available in our mills or research laboratory, and in such instances, the Technical Service Department correlates all available information bearing on the problem and works closely with the customer until a solution is reached.

A Problem of Dezincification

Frequently, customers are aided in improving their products through a change in metal specifications which results in longer life, better performance, more favorable price or a combination of all three. For example, a manufacturer of metal bellows was using a brass composed of 80% copper, remainder zinc. This alloy could be readily drawn and formed, but dezincification was causing premature failure of the part under certain conditions.

After taking into consideration various factors such as governmental limitations on certain materials, the customer's competitive price situation and necessary physical properties, an alloy composed of 81.0% copper, 1.1% tin, remainder zinc was suggested. This alloy formed satisfactorily, possessed sufficient spring properties, fulfilled price and governmental requirements, and most important of all did not fail through dezincification as had the previous alloy.

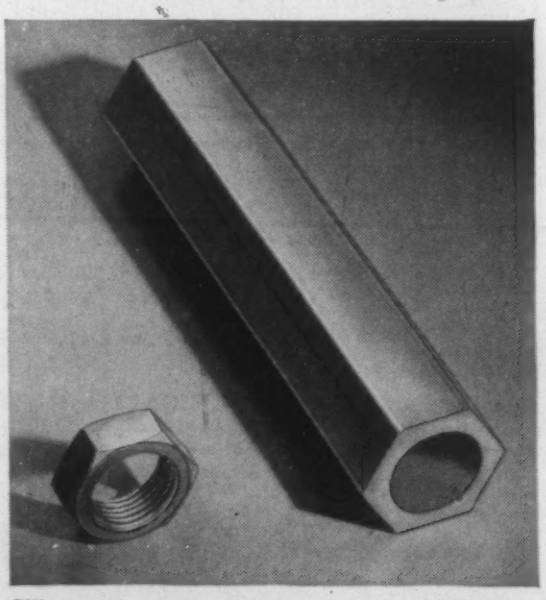
A Stronger Alloy for Connector Bolts

In another case which came to the attention of our Technical Service Department a customer had been using copper strip for the manufacture of pressure pads for electrical split bolt connectors. Malleability and corrosion resistance were satisfactory, but more strength was required. A change in metal specifications was indicated, and an alloy made up of 2.75% aluminum, 0.35% silicon, remainder copper was recommended. This alloy, almost as malleable as copper, possessed fine corrosion resistance and the ability to attain exceptionally high strength by cold working.

Varied Problems Are Handled

In some cases an alloy suggested by our Technical Service Department has resulted in a complete change in manufacturing procedure by the customer resulting in a product with better physical properties. In the case of a manufacturer making large cast nuts, an aluminum bronze heavy walled tube, hexagonal outside, was developed. Nuts machined from this tubing are superior in physical properties to those made from castings.

Another type of problem was that of a manufacturer who required a copper-base alloy which could be seam and spot welded and also would be practical for deep drawing operations. A yellow brass alloyed with a small percentage of silicon was tried out and found satisfactory for the purpose. This alloy can readily be formed and also possesses sufficiently low thermal and electrical conductivities to make it suitable for resistance welding.

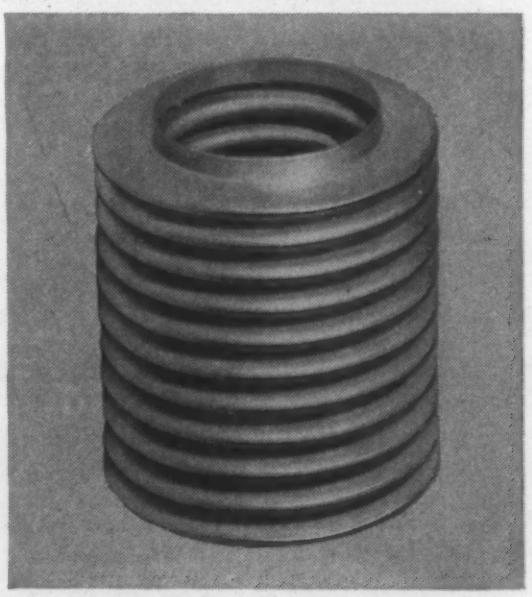


Silicon Aluminum Bronze special tubing, and hexagonal nut made from it.

A New Spring Material

With the scarcity of tin, and government conservation orders limiting the applications for which phosphor bronze can be used, many of our customers required a material with suitable spring characteristics and other properties, which could be substituted for phosphor bronze in certain applications. As an answer to this need Bridgeport's research laboratory developed an aluminum bronze which has been used successfully for diaphragms, spring contacts, bellows, spring type bearings and similar applications.

One interesting application, developed through the Technical Service Department, is a spider for self-centering bearings. The alloy was found to possess the necessary strength, spring properties and satisfactory formability for this application. Other every-day types of applications for the alloy are the cap grips and clips for modern fountain pens and clutches that grip the lead of automatic pencils.



Metal bellows used for temperature and pressure controls. Must have satisfactory spring properties and good corrosion resistance.

Cupro Nickel Recommended

A different sort of problem was put up to the Technical Service Department by the manufacturer of a small immersion heater made from chromium plated copper tubing. Unfortunately, the chromium pealed off after very little use thus allowing the tubing to become badly discolored. Cupro nickel has replaced the chromium plated copper and gives very satisfactory results.

Condenser and Heat Exchanger Tubing

Bridgeport's Technical Service Department also works with users and manufac-

(*Continued on page 2, column 2*)

COPPER ALLOY BULLETIN

CAUSES OF CORROSION

This article is one of a series of discussions by C. L. Bulow, research chemist of the Bridgeport Brass Company.

EFFECT OF STRESS ON CORROSION

Vibrating or Cyclic Stresses Accelerate Cracking

Almost a century has passed since August Wohler conducted his experimental study of the strength of materials under repeated stress. This led to the establishment of his critical value of stress below which cracking failures will not take place even after an enormous number of cycles of stress. This critical value which is now called "endurance limit" or "fatigue limit" is probably the most important index of the fatigue strength of a metal. This subject is of increasing importance because of the more wide spread use of high speed machinery where numerous cycles of stress occur in a very short period of time.

Nature of Fatigue Cracking

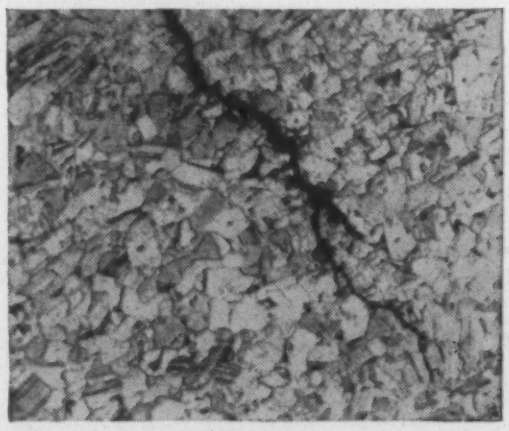
Subsequent work by other investigators indicated that under alternating stresses, repeated slippage along the microscopic crystal planes of the metal may lead to the formation of minute cracks. These minute cracks grow and weaken the metal until cracking failure suddenly occurs. The final fracture usually has the following characteristics:

(1) shows very little if any reduction in cross-sectional area.

(2) reveals the bright natural color of the metal.

(3) the fracture has a coarse crystalline appearance, especially in the area where the final fracture occurs, with the rest of the crack discolored and smoothed by rubbing of the sides of the crack during its growth.

(4) the crack is predominantly transcrystalline (see figure 1).



Photomicrograph of fatigue crack in silicon aluminum bronze developed in laboratory fatigue test after 10,000,000 cycles at a stress of 45,000 psi.

The crystalline appearance of the fracture, originally led to the erroneous impression that the metal had "crystallized". With the advent of the metallurgical microscope, it was shown that the crystalline appearance results from fatigue fracture starting in the cleavage plane or crystal boundaries of the metal.

Bridgeport's Technical

(*Continued from page 1*)

turers of condenser and heat exchanger equipment in power plants, petroleum refineries, petro-chemical plants and process industries. Many corrosion resistant condenser and heat exchanger alloys are available. For most practical results, engineers working with laboratory personnel, are in a position to try out various alloys and observe them under actual service conditions.

Wherever there are problems of severe double corrosion which may lead to premature shut-downs, or where there is the possibility of a metal or alloy contaminating the color or taste of a product, Duplex Tubing is worth investigating.

For example, in heat exchangers for the production or handling of certain acid solutions, formaldehyde, resins, sulphur compounds, paints, and varnishes, petroleum products, foods and beverages, Bridgeport Duplex Tubing, made up of a copper-base alloy to the circulating water side and aluminum to the product side, should be tested to avoid product contamination or withstand excessive corrosive attack.

In the handling and manufacture of ammonia and other nitrogen compounds Duplex Tubing with a copper-base alloy to the water or brine side and steel to the nitrogen compound side has resulted in longer life and improved heat transfer properties. Ammonia refrigeration systems furnish a very important application for Duplex Tubing with the above combination.

Many combinations are available, such as Bridgeport Admiralty, Arsenical Muntz*, Cupro Nickel, Cuzinal, Duronze IV** (aluminum bronze), or Copper with steel, stainless steel, monel, aluminum, or nickel.

The Technical Service Department can be contacted through your nearest Bridgeport office.

*Reg. U. S. Pat. No. 2118688
**U. S. Pat. No. 2093380

The Copper Alloy Bulletin has taken on a new appearance this month — different paper, different ink. It's part of our program to help paper manufacturers conserve facilities.

Readers who would like to receive the Copper Alloy Bulletin regularly should send their names and addresses to Bridgeport, requesting that their names be added to our mailing list.

NEW DEVELOPMENTS

This column lists items manufactured or developed by many different sources. None of these items has been tested or is endorsed by the Bridgeport Brass Company. We will gladly refer readers to the manufacturer or other sources for further information.

A New Type Fastening has been developed for application on access panels, inspection doors, and appliances requiring a means for quick opening and closing between two sheet-metal panels. The fastening consists of a metal base carrying a formed spring with cam surfaces and a stud that applies in a grommet. The base unit is secured to one of the two sheets to be held together. The stud and grommet apply in the other sheet. Turning stud through 90° applies it in the spring or releases it. **No. 690**

Metal Treating Liquid Material to black finish copper alloys without copper plating first. It has also been used to produce black finish on steel suitable for waxing, lacquering or as a bond for paint finishes. It is of porous character, prior to waxing, and anchors paint securely. **No. 691**

Two New Hydrogen Thyratron Tubes have been developed for timing welding operations, electronic heating, and electroplating. Also applicable to marine and aircraft radar and pulse communicating equipment. The two units measure 10 and 7″ in overall length and can be installed in any position. Peak anode rating is 325 and 90 amp., 16 and 8 kv. **No. 692**

A New Power Driven Press designed for bending, straightening, forcing, push broaching, riveting, and staking. It can be employed to exert momentary or sustained pressure by use of a foot pedal. Standard stroke is maximum at 9″. Special stroke to 12, 15, or 18″ can be specified. It is driven by a 5-hp. motor. **No. 693**

Temperature-controlled Valve for application of a steam supply line determines pressure in steam delivered to a unit of process equipment in flow-through or dead-end service. Valve is furnished in temperature ranges from 70 to 170°F., 120 to 220° and 170 to 270°. Pressure range is 25 to 300 pounds. Operation can be adjusted to desired temperature and pressure within the ranges in which the valve is available. **No. 694**

New Electronic Equipment generates and employs supersonic waves on the order of 50 to 1000 kc to detect flaws in solid or laminated materials. It is said to be particularly suited for non-destructive testing of rolled and extruded materials made of steel, aluminum, bronze, copper, alloyed metals and plastics. It will detect and locate minute defects in the material or in joining surfaces between two materials. **No. 695**

BRASS, BRONZE, COPPER, DURONZE, NICKEL SILVER, CUPRO NICKEL

Warehouse Service in Principal Cities

STRIP AND SHEET—For drawing, stamping, forming, spinning. Leaded alloys for machining, drilling, tapping. Silicon bronze, phosphor bronze for corrosion resistance. Alloys suitable for springs. Engravers' copper and brass.

WIRE—Cold Heading alloys for screws, bolts, nuts, nails, fastenings, electrical connectors, Phono-Electric trolley and contact wires.

ROD—Alloys for screw machine operation. Duronze III high strength, corrosion-resistant, good for machining and hot forging. Hot forging and cold heading alloys. Welding Rods. Copper-covered ground rod.

TUBING—For miscellaneous fabrication. For condensers and heat exchangers. For water, air, oil and hydraulic lines.

DUPLEX TUBING—for conditions too severe for a single metal or alloy.

PIPE—Brass and copper for plumbing.

FABRICATED GOODS—Plumbing brass goods. Radiator air valves. Aer-a-sol insecticide dispensers. Automobile tire valves.

TECHNICAL SERVICE—Staff of experienced, laboratory-trained men available to help customers with their metal problems.

WAREHOUSE SERVICE—Warehouse and jobbers stocks available for prompt delivery in principal cities.

TECHNICAL LITERATURE — Manuals and handbooks available for most products.

"Bridgeport" BRASS

BRIDGEPORT BRASS

BRIDGEPORT BRASS COMPANY, BRIDGEPORT 2, CONN. • ESTABLISHED 1865

FIRST . . . LOOK AT THIS

An oscillogram, magnified 10,000 times in terms of spindle movement, showing shift of axis of lathe-spindle (3×10^{-4} in.)

THEN . . . AT THIS

An oscillogram, also magnified 10,000 times in terms of spindle movement, showing smaller shift (10^{-4} in.) after five-minute shutdown.

These Photographic Recordings, by showing effects of shutdown on lathe-spindle accuracy, helped produce precision parts in quantity.

THE PROBLEM was the mass production of small precision parts on a lathe to exceptionally close tolerances . . . and tolerances were not being met . . .

Test apparatus employing an electronic circuit in conjunction with photographic recording equipment was set up to study the performance of lathe-spindles. It proved, as shown above, that the longer the shutdown, the greater the shift of spindle axis . . .

Immediate product improvement . . . with a lower rejection rate . . . was achieved through this investigation. And this was just the beginning – further study of additional oscillograph traces revealed other irregularities in spindle performance which led to improvements in design.

This is only *one* way in which Kodak photographic equipment, film, and paper are helping solve problems in engineering, design, production, research. For information on photographic recording materials write for the new booklet, "Kodak Materials for the Photography of Cathode-Ray Tubes."

EASTMAN KODAK COMPANY
INDUSTRIAL PHOTOGRAPHIC DIVISION
ROCHESTER 4, N. Y.

INSTRUMENT RECORDING

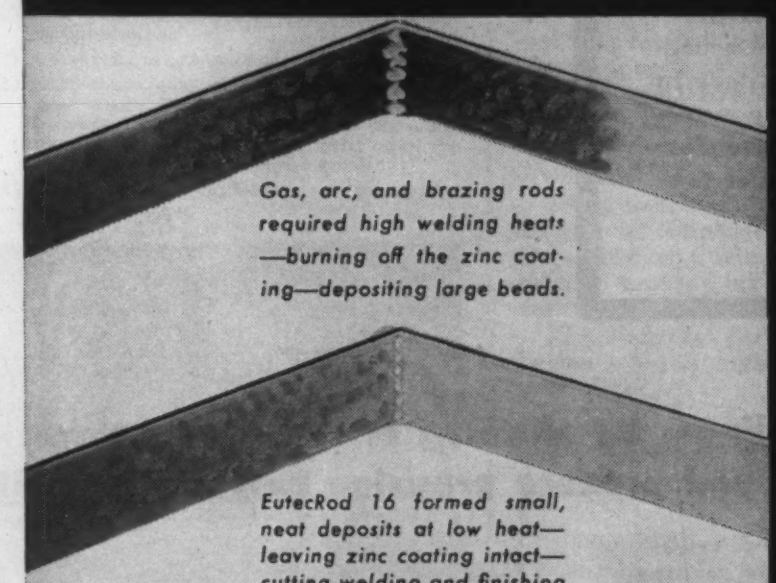
. . . another important function of photography

Kodak

Industry Endorses EUTECTIC *Low Temperature* WELDING RODS* and FLUXES

EUTECTIC Helps Keller Metals, Inc.

"We beat competition by cutting production time 800%—welding with EUTECTIC."



Gas, arc, and brazing rods required high welding heats —burning off the zinc coating—depositing large beads.

EutecRod 16 formed small, neat deposits at low heat— leaving zinc coating intact— cutting welding and finishing time 800%.

WHAT IS EUTECTIC?

EUTECTIC *Low Temperature* WELDING RODS* *are a new type of welding alloys which—*
1. Bond to base metals well below the base metal melting point. 2. Form exceedingly strong joints through surface alloying. 3. Give faster, better bonds at lower cost. 4. Avoid the dangers of stress and distortion characteristic of fusion welding and brazing.

EUTECTIC WELDING ALLOYS CORPORATION
ORIGINATORS OF Low Temperature WELDING ALLOYS
40 Worth Street New York 13, N. Y.

Everyday EUTECTIC *Low Temperature* WELDING RODS* are proving to be the best in production welding. Hundreds of manufacturers are finding their many advantages to be the deciding factors in bidding low on important jobs and getting the contracts.

Here is a typical report from Keller Metals, Inc. This company bid on a big air-conditioning contract and *got it!* With the use of EutecRod 16, they were able to cut production time and manufacturing costs to the bone.

"The job called for welding large panels and trays made of 18 gage galvanized iron. We tried several different rods, but the high welding heats required, oxidized the zinc coating, necessitating recoating after welding. In addition, the weld deposits were so large that they had to be ground down. These additional operations required too much time and made the cost of fabrication prohibitive.

"Then we tried EutecRod 16, applied with the oxyacetylene torch. With its use, we cut production time for one unit from 30 minutes to 5 minutes. The low heat of application did not affect the zinc coating. Also, small, neat fillets were obtained without grinding.

"With EutecRod 16, we obtained a sound, leakproof construction of high strength and smooth appearance at low cost, and we got the contract."

Please send me complete information on how to purchase a trial selection of 9 EutecRods for everyday use: also facts on EUTECTIC *Low Temperature* WELDING RODS and Fluxes. Dept. MM-6.

Name.....

Company.....

Address.....

For Your Welding Problems—Call EUTECTIC First

140 Field Engineers, in all principal cities of the United States and Canada, to serve you.

*Trade-mark Reg. U. S. Pat. Off.

Manufacturers' Literature

Materials

Steels and Irons

Tool Steel. A data sheet published by the *Crucible Steel Co. of America* gives user information about HYCC tool steel, a high carbon-high chromium die steel. (A-63)

Heat Resistant Alloys. Catalog 101 of the *Hoskins Manufacturing Co.* shows various heat treating fixtures, baskets, etc., made of heat resisting alloys. (A-67)

Tool Steels. Jessop Cast-to-Shape tool steels are described in an illustrated booklet published by the *Jessop Steel Co.* (A-62)

Steel Castings. Carbon molybdenum steel castings for high temperature and pressure applications are described in a leaflet of the *Lebanon Steel Foundry.* (A-66)

Stainless Steel Trade Names. A booklet listing both obsolete and current trade names of stainless steels has been prepared by the *Rustless Iron & Steel Div., American Rolling Mill Co.* (A-65)

Air Hardening Steel. Air-Tru flat ground stock, made by *Simonds Worden White Co.*, is described in a 4-page folder. (A-64)

Tool Steels. Allegheny Ludlum Steel Corp. (A-31)

Zinc-Plated Steel. American Nickeloid Co. (A-37)

High-Strength Steels. American Rolling Mill Co. (A-33)

Low Alloy Steel. Bethlehem Steel Co. (A-52)

Free-Cutting Open Hearth Steels. Bliss & Laughlin, Inc. (A-25)

Alloy Steels. Carpenter Steel Co. (A-16)

High-Speed Steels. Cleveland Twist Drill Co. (A-28)

Stainless Steel Sheets. Eastern Stainless Steel Corp. (A-29)

Tool Steel. Firth Sterling Steel Co. (A-59)

Alloy Steels. Peter A. Frasse & Co., Inc. (A-12)

Stainless Clad Steel. Granite City Steel Co. (A-2)

High Strength Steel. Great Lakes Steel Corp. (A-10)

Structural Steel. Inland Steel Co. (A-45)

Cast Irons. Meehanite Research Institute. (A-58)

Heat and Corrosion Resistant Castings. National Alloy Steel Div., Blaw-Knox Co. (A-60)

Steel Castings. Steel Founders' Society of America. (A-57)

High-Tensile Steel. Youngstown Sheet & Tube Co. (A-19)

Nonferrous Metals

Alloy Wire. Corrosion and heat resistant metallic wire, rod and strip products for electrical and heating purposes are listed in a 32-page, spiral-bound booklet published by the *Alloy Metal Wire Co., Inc.*, Technical data tables are also included. (B-46)

Precious Metals. A 4-page pramphlet entitled "Platinum, Gold, Silver for Science, Industry and the Arts" describes some of the products of the *American Platinum Works.* (B-50)

Bronze. The various products and services offered by *Ampco Metal, Inc.* are listed in a new 4-page bulletin. Aluminum bronze and copper base alloys, continuous cast bronzes, welding electrodes, non-sparking tools and engineering services are included in Bulletin 72. (B-42)

Corrosion Resistant Alloy. "Eatonite," a corrosion and heat resistant Cr-Ni-W-Co alloy, and its applications are described in an illustrated, 9-page booklet available from the *Eaton Manufacturing Co.* (B-47)

Nonferrous Castings. The aluminum, bronze and copper products and castings of the *John Harsch Bronze & Foundry Co.* are pictured in a 4-page folder. (B-48)

Please Use the Coupon on Page 1674

Engineering Bronzes. Bridgeport Brass Co. (B-10)

Die Matrix Alloys. Cerro de Pasco Copper Corp. (B-22)

Brass and Copper Terms. Chase Brass & Copper Co., Inc. (B-8)

Aluminum—The Versatile Metal. Reynolds Metals Co. (B-45)

Nickel-Silver Alloys. Riverside Metal Co. (B-15)

Phosphor Bronze. Seymour Mfg. Co. (B-17)

Babbitt. United American Metals Corp. (B-43)

Plastics and Related Materials

Dielectric Heater. "Airtronics" heaters are illustrated in a 4-page folder put out by the *Airtronics Mfg. Co.* (C-40)

Deep Drawing Laminates. The *Andover Kent Co.* announces the availability of deep-drawn laminated plastic shapes in a new 4-page leaflet. (C-46)

Celanese Plastics. A new 6-page pamphlet of the *Celanese Corp. of America* shows the uses and properties of celanese plastics. (C-42)

Plastics Specifications. A specification sheet is available from *Creative Plastics Corp.* (C-54)

Plastics Information. "What are Plastics" is the title of a new 12-page booklet released by the *Plastics Div.* of *General Electric Co.* This booklet gives the uses and properties of many different types of plastic materials. (C-49)

Plastic Products. The *Ideal Plastics Corp.* advertises its facilities for making injection, extrusion and compression molded products in a 4-page leaflet. (C-51)

Valve Handwheels. "Kys-ite" plastic handwheels, made by *Keyes Fibre Co.*, are described in an illustrated, 4-page folder. (C-45)

Dielectric Heater. The specifications of the portable thermal "Bantam" dielectric heater

are described in a single-page leaflet released by *W. T. LaRose & Assoc.* (C-53)

Injection Molding Machines. A 6-page leaflet published by the *Leominster Tool Co., Inc.*, gives the specifications for automatic hydraulic injection molding machines. (C-50)

R. F. Generators. Radio frequency heating devices for molding and bonding are described in a series of specification sheets published by the *Northwest Syndicate, Inc.* (C-58)

Plastics Forms. The various plastic forms sold by the *Plax Corp.* are pictured in a 4-page folder recently released. (C-41)

Molded Products. A 7-page pamphlet illustrates the molding equipment used for making large and small injection molded heavy-section parts by the *Prolon Plastics Div.* of *Prophylactic Brush Co.* (C-52)

Dielectric Heater. Specifications and uses for the Model D5G general purpose Raytherm are given in an 8-page pamphlet published by the *Industrial Electronics Div.* of *Raytheon Mfg. Co.* (C-43)

Optical Plastic. "Reflexite," a highly reflective plastic material made by the *Reflexite Corp.*, is described in a 4-page, pocket-sized folder. (C-47)

Plexiglas. Instructions for handling, fabricating, polishing and cleaning Plexiglas are concisely given in this leaflet published by *Rohm & Haas Co.* (C-31)

Plastic Dyes. "Rez-N-Dye" cold dip plastic dies are made by the *Schwartz Chemical Co.* (C-48)

Transfer Molding. The *Shaw Insulator Corp.* pictures some of its transfer molded products in a 4-page leaflet. (C-55)

Molded Plastic Parts. A 16-page colorful booklet describes the thermoplastic products manufactured by The *Standard Products Co.* (C-57)

Press. The features of a 50-ton plastic molding press are described in a leaflet issued by the *Turner Manufacturing Co., Ltd.* (C-44)

Molded Plastic Parts. The history and products of the *Waterbury Companies, Inc.*, are given in a recently released folder. (C-56)

Plastic Coating. Better Finishes & Coatings, Inc. (C-24)

Rubber Products. H. O. Canfield Co. (C-36)

Plastics. Plastics Div., Dow Chemical Co. (C-11)

Casting Resin. Durez Plastics & Chemicals, Inc. (C-5)

Plastic Data Book. Formica Insulation Co. (C-13)

Cellulose Acetate. Hercules Powder Co. (C-10)

Resin Coating. Nukem Products Corp. (C-34)

Laminated Plastics. Taylor Fibre Co. (C-28)

Rubber and Plastics. Vulcanized Rubber & Plastics Co. (C-39)

Other Nonmetallic Materials

Industrial Ceramics. An illustrated 32-page booklet (Bulletin No. 444, published by the *American Lava Corp.*) lists the forms, applications and technical data for electrical and other industrial ceramic products made of AlsiMag and Lava. (D-11)

Silica Glass. The characteristics and applications of Vycor, a 96% silica glass, are given in a leaflet published by the *Corning Glass Works.* (D-9)

Mycalex. A new 27-page booklet describes the stone-like product composed of mica and a special glass manufactured by the *Chemical Dept.* of the *General Electric Co.* The properties and applications of Mycalex are fully described. (D-10)

Fiberglas. Owens-Corning Fiberglas Corp. (D-7)

Parts and Metal-Forms

Stampings. A 6-page folder describes the stampings manufactured by the *HPL Manufacturing Co.* (E-73)

Forgings. A 12-page, illustrated booklet shows the facilities and products of the *Smith-Armstrong Forge, Inc.*, producers of rough and semi-finished flat die forgings. (E-74)

Heat Treated Aluminum Castings. Acme Aluminum Alloys, Inc. (E-20)

Special Castings. Advance Foundry Co. (E-5)

Heat- and Corrosion-Resistant Castings. Alloy Casting Co. (E-14)

Seamless and Welded Tubes. Babcock & Wilcox Co. (E-41)

Alloy Steel Castings. Chicago Steel Foundry Co. (E-31)

Designing Impression Die Forgings. Drop Forging Assn. (E-26)

Alloy Castings. Duraloy Co. (E-18)

Nickel-Chromium Castings. Electro Alloys Co. (E-19)

Permanent Magnets. Indiana Steel Products Co. (E-64)

Steel Music Wire. Johnson Steel & Wire Co. (E-46)

Rings. King Fifth Wheel Co. (E-70)

Beryllium Copper Wire. Little Falls Alloys, Inc. (E-10)

Silver and Gold Solders. D. E. Makepeace Co. (E-48)

Heat- and Corrosion-Resistant Castings. Michiana Products Corp. (E-65)

Designing for Die Casting. New Jersey Zinc Co. (E-24)

Plywood Tubing. Plymold Corp. (E-42)

Precision Shapes. Precision Shapes, Inc. (E-57)

Corrosion-Resistant Masonry. U. S. Stoneware Co. (E-17)

In this Manufacturers' Literature INDEX, new bulletins are given complete reviews, and previously described older bulletins are merely listed in their proper places.

Coatings and Finishes

Phosphate Coatings. Rust and wear resistant treatments are described in a 4-page folder of the *American Chemical Paint Co.* (F-13)

Zinc Finish. Chemical Corp. (F-2)

Protective Finishes. Mitchell-Bradford Chemical Co. (F-9)

Corrosion-Resistant Finish. Rheem Research Products, Inc. (F-4)

Methods and Equipment

Melting, Refining and Casting

Induction Furnaces. Ajax Engineering Corp. (G-21)

(Continued on page 1676)

MAIL THIS COUPON FOR FREE LITERATURE

Materials & Methods, 330 West 42nd St., New York 18, N. Y.

I should like a copy of each piece of Manufacturers' Literature specified by number below. *We request students to send their inquiries to the manufacturers*

NAME _____ POSITION _____

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PLEASE PRINT 6/46

STRAIGHT DOWN THE ALLEY...to your problems!

If the production and maintenance problems of the metal industries were pins on a bowling alley, you'd find many you could topple with one ball— "dag" colloidal graphite. The five above are typical.

Your problems, too, might topple to that unique combination of properties which gives "dag" colloidal graphite such versatility: slippery, finely divided, soft, resistant to high temperatures, chemically inert, pure, opaque, a good conductor, and capable of permanent adsorption on metal surfaces.

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- 422 Facts about "dag" colloidal graphite as a PARTING COMPOUND. ☐
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- 431 Facts about "dag" colloidal graphite for IMPREGNATION AND SURFACE COATINGS. ☐
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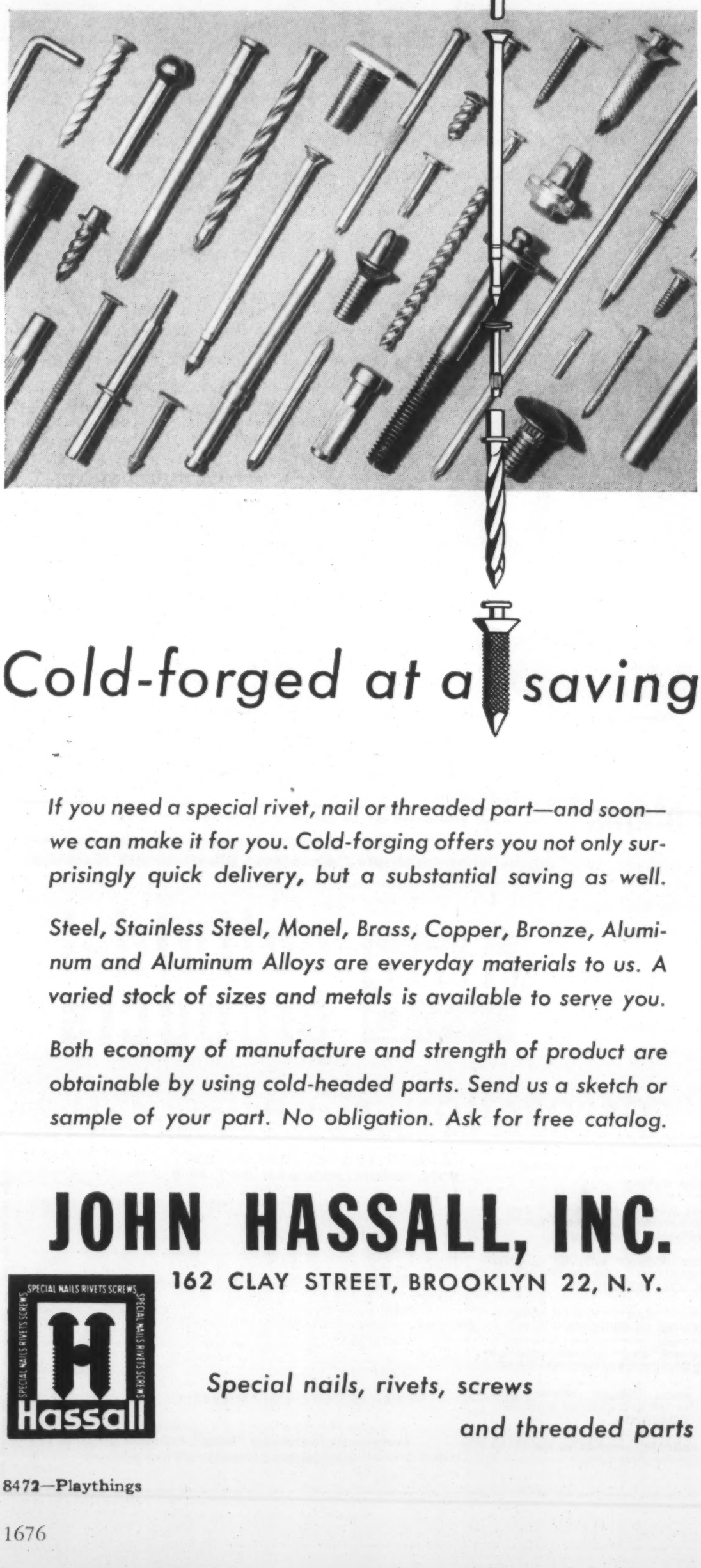

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SPECIAL NAILS RIVETS SCREWS Hassall

Special nails, rivets, screws and threaded parts

8472—Playthings

Blowerless Furnaces. Baker & Co., Inc. (G-2)

Die Casting Machine. DCMT Sales Corp. (G-33)

Core Baking and Mold Drying Oven. Despatch Oven Co. (G-25)

Melting Furnaces. Fisher Furnace Co. (G-22)

Electrode Care. International Graphite & Electrode Corp. (G-34)

Hydride Process. Metal Hydrides, Inc. (G-15)

Casting Sealant. Monsanto Chemical Co., Plastics Div. (G-10)

Core Binder. Resinous Products & Chemical Co. (G-29)

Pressworking, Stamping, Forging, Powder Metal Forming

Punch Press. The specifications of the 12- and 14½-ton "Diamond" power punch presses sold by the *Graham Machine Tool Co.* are given in a new single-page leaflet. (J-17)

Arbor Presses. The hand, air and motor operated arbor presses built by the *K. R. Wilson Co.* are illustrated in a 32-page booklet recently released. (J-19)

Presses. "Pressurematic presses, built by *Lempco Products, Inc.,* are described in an 8-page illustrated pamphlet. The specifications for 40- and 60-ton hydraulic presses and 2-ton arbor presses are given. (J-18)

Machining and Grinding

Air Driven Saw-File. The uses of the Air-Speed saw, a combination portable saw and file made by the *Air-Speed Tool Co.,* are pictured in a pocket-sized folder. (L-70)

Duplicating Attachment. The Bailey duplicating attachment for use with standard machine tools is described in an 8-page pamphlet of the *Bailey Meter Co.* (L-79)

Surface Grinders. The Blanchard general catalog gives the specifications for the surface grinders manufactured by the *Blanchard Machine Co.* (L-64)

Rebilt Machine Tools. Expertly rebuilt machine tools and the methods used in rebuilding them at the *Botwinik Brothers'* plant are pictured in a 20-page, illustrated booklet. (L-74)

Precision Equipment. Imported precision machine tools and instruments are listed in a leaflet available from the *Cosa Corp.* (L-72)

Keyseaters. The machines made by the *Davis Keyseater Co.* are described in a 4-page folder. (L-80)

Grinding Wheel Information. "101 Grinding Questions Answered" is the title of a 12-page booklet released by the *Dayton Grinding Wheel Div.* of *Simonds Worden White Co.* (L-78)

Metal Cutting Machines. Specifications of the new DeWalt "Wet-Cut" metal cutting machine are given in a 4-page folder. *DeWalt Products Corp.* (L-86)

Planer-Mills. The Gray planer type milling machines are described in an 18-page catalog of the *G. A. Gray Co.* (L-61)

Boring Mill Accessories. A new 48-page booklet containing information about the various attachments and accessories used on G & L horizontal boring mills has been published by the *Giddings & Lewis Machine Tool Co.* (L-69)

Milling Adapter. The Globe Miller, a milling attachment for engine lathes, is described in a 6-page leaflet published by the *Globe Products Mfg. Co.* (L-67)

Tool Grinders. Carbide tool grinders, finishing machines and polishing lathes are pictured in a pocket-size folder published by the *Hammond Machinery Builders, Inc.* Bulletin 1201. (L-91)

Wheel Forming Device. Several forming devices for grinding wheels are pictured in an 8-page pamphlet of the *J & S Tool Co.* (L-85)

Precision Machine Work. Examples of the precision cylinder work performed by the *Karge & Son Machine Co.* are pictured in a new leaflet. (L-71)

Milling Machines. A short history of the company and its products and specifications of the milling and boring machines made by *Kearney & Trecker Corp.* are included in a new 48-page, illustrated general catalog. (L-88)

Broach Sharpening. An illustrated folder showing the types, care and handling of broaches, and a broach sharpener, is available from the *Lapointe Machine Tool Co.* (L-75)

Universal Grinder. A 6-page leaflet describes the features of the Model HGX universal grinder (for turning and grinding) built by the *Lempco Co.* (L-77)

Designing Service. A new 14-page booklet describes the designing services (for new products, machines and tools) offered by the *Machine & Tool Designing Co.* (L-68)

Grinding Wheels. Catalog No. T-46, a 32-page booklet, gives suggestions and recommendations for tool room and surface grinding jobs. *Macklin Co.* (L-90)

Cut-Off Machine. The specifications of machines for cutting off tubing and pipe are given in a leaflet of the *Modern Machine Tool Co.* (L-81)

Tipped Milling Cutters. Three leaflets dealing with carbide tipped face and end mills, shell end mills, and end mills, respectively, have been published by the *Nelco Tool Co., Inc.* (L-76)

Grinding Movies. "Lessons in Grinding" is the title of a pamphlet that lists the various Norton training films (16-mm. Kodachrome With Sound) available from the *Norton Co.* (L-57)

Threading Attachment. A threading attachment for lathes called Thread Faster is made by *Peerless Tool & Engineering Co.* and is described in a 4-page folder. (L-89)

Magnetic Chucks. Rockford Magnetic Products Co. offer a 24-page booklet about various magnetic chucks. (L-82)

Friction Sawing. Almost any material may be cut with a friction saw. This 32-page, illustrated booklet gives applications and machines for this type of operation. *Tannewitz Works.* (L-92)

You don't have to baby . . . *the Profilometer!*

In March of this year Type Q Profilometer No. 1 celebrates its third birthday. This is the Profilometer used steadily for three years by Frank W. Kabat, PRCo representative.

In three years, his Profilometer has:

- Traveled over 200,000 miles by train, automobile, and plane.
- Visited manufacturing plants in cities from Los Angeles to Boston.
- Been operated by hundreds of inexperienced operators.
- Been dropped on concrete pavements by cab drivers and thrown onto luggage racks and train platforms by porters.

This rough treatment exceeds anything likely to happen to a Profilometer in use in a plant. And despite this treatment, Type Q Profilometer No. 1 still is as accurate, efficient, and dependable as any Profilometer ever made.

- Repairs made on this Profilometer, if charged at regular rates, amount to *less than $100.*

This is concrete evidence of the ability of the Profilometer to thrive under heavy use in shops and production departments.

If you are interested in the Profilometer and its uses in controlling surface-finish production, ask us to have our representative call on you. Catalog on request.

Profilometer is the registered trade-mark indicating Physicists Research Company's brand of surface-roughness gaging instrument.

PHYSICISTS RESEARCH COMPANY

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Niagara Aero After Cooler Protects Air Processes from Moisture Damage

Industries requiring dry compressed air need the Niagara Aero After Cooler. It provides cleaner, drier air for pneumatic tools, spray guns, sand and shot blast equipment, air cleaning nozzles and situations where air is introduced into materials in process.

The Niagara Aero After Cooler is based on the evaporative cooling principle. It does not consume cooling water and thus pays for itself quickly from savings in water bills. The patented "Balanced Wet Bulb" method assures the lowest air temperature, and controls exactly the jacket water temperature.

Write for Niagara Bulletins 96 and 98 for further information. Protection of air tools from moisture damages and saving in repairs makes the Niagara Aero After Cooler worth investigating.

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Over 30 Years of Service in Industrial Air Engineering

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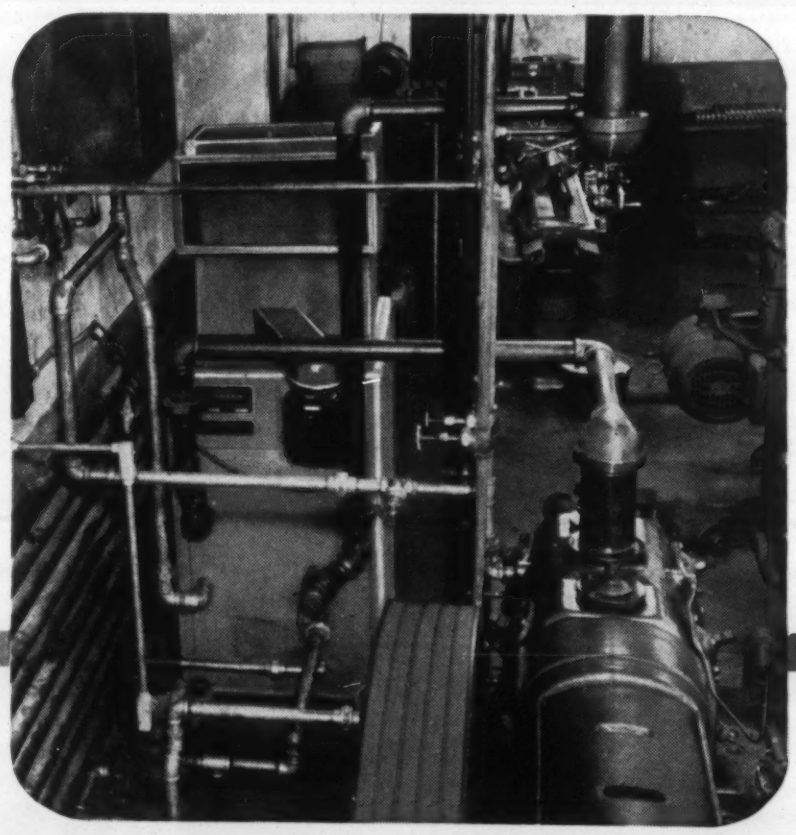
Field Engineering Offices in Principal Cities



INDUSTRIAL COOLING HEATING • DRYING

NIAGARA

HUMIDIFYING • AIR ENGINEERING EQUIPMENT

Hand Screw Machines. The features and specifications of Wade hand screw machines are explained in a 12-page, illustrated booklet published by the *Wade Tool Co.* (L-83)

Thread Grinders. Portable Grindall precision thread grinding attachments for lathes, millers and boring mills are illustrated in a new 4-page folder. *Walz & Krenzer, Inc.* (L-73)

Grinding Data Book. Carborundum Co., Refractory Div. (L-24)

Coolant Filter. Cuno Engineering Corp. (L-21)

Tapping Machines. Detroit Tap & Tool Co. (L-44)

Lathes, Balancing Machines, Etc. Gisholt Machine Co. (L-15)

Metal Working Machinery. Kling Brothers Engineering Works. (L-9)

Grinding Wheel Data. Safety Grinding Wheel & Machine Co. (L-59)

Grinding With Oil. D. A. Stuart Oil Co. (L-12)

Heat Treating

Furnaces. "Electric Salt Bath Furnaces" is the title of a new catalog available from the *Ajax Electric Co., Inc.* (M-78)

Induction Heating Equipment. Budd induction heating equipment is described in a 24-page booklet published by the *Budd Wheel Co.* (M-84)

Combustion Equipment. Gas burners, proportioning valves, injectors, and burners are described in detail in a series of data sheets included in a folder published by the *Industrial Div.* of *Bryant Heater Co.* (M-82)

Heat Treatment. The facilities for job heat treating at the *Lakeside Steel Improvement Co.* are described in a 10-page pamphlet. (M-83)

Belt Conveyor Furnaces. Pictures of the belt-type conveyor furnaces made by the *W. S. Rockwell Co.* are included in the 6-page folder (Bulletin No. 421), recently released. (M-80)

Cold Treatment Machines. A low temperature machine for the industrial cold treatment of metals is advertised in a 4-page folder of *Super-Treat, Inc.* (M-81)

Convection Furnaces. Bulletin CG-43 of the *Surface Combustion Corp.* discusses the outstanding features of pit and oven type convection furnaces. In this 7-page bulletin the construction features and ratings of these furnaces are given. (M-62)

Gas Furnaces. American Gas Furnace Co. (M-79)

Car Bottom Furnaces. Hevi-Duty Electric Co. (M-22)

Heat Treating and Laboratory Furnaces. K. H. Huppert. (M-75)

Induction Heating Data Sheets. Induction Heating Corp. (M-26)

High Frequency Induction Heating Equipment. Lepel High Frequency Laboratories, Inc. (M-28)

Please Use the Coupon on Page 1674

Gas-Fired Furnace. Lindberg Engineering Co. (M-51)
Chilling Units. Motor Products Corp., Deep-Freeze Div. (M-8)
High Frequency Induction. Ohio Crankshaft Co. (M-29)
Salt Baths. Park Chemical Co. (M-20)
Heat Treating Furnaces. Salem Engineering Co. (M-52)
Liquid-Gas Separator. Selas Corp. of America. (M-15)
Specifications and Heat Treating Chart. Sunbeam Corp. (M-43)
Electric Salt Bath Furnaces. Upton Electric Furnace Div., Commerce Pattern Foundry & Machine Co. (M-54)

Welding, Joining, Fastening

Screw Thread Inserts. Inserts for use in rehabilitating tapped holes having stripped or worn threads are shown in Bulletin No. 300 of the *Aircraft Screw Products Co., Inc.* (O-111)

Metal Cutter. The Thomas metal disintegrator, an electric tap removing and metal cutting device, is pictured in a 6-page folder put out by the *Clinton Machine Co.* (O-110)

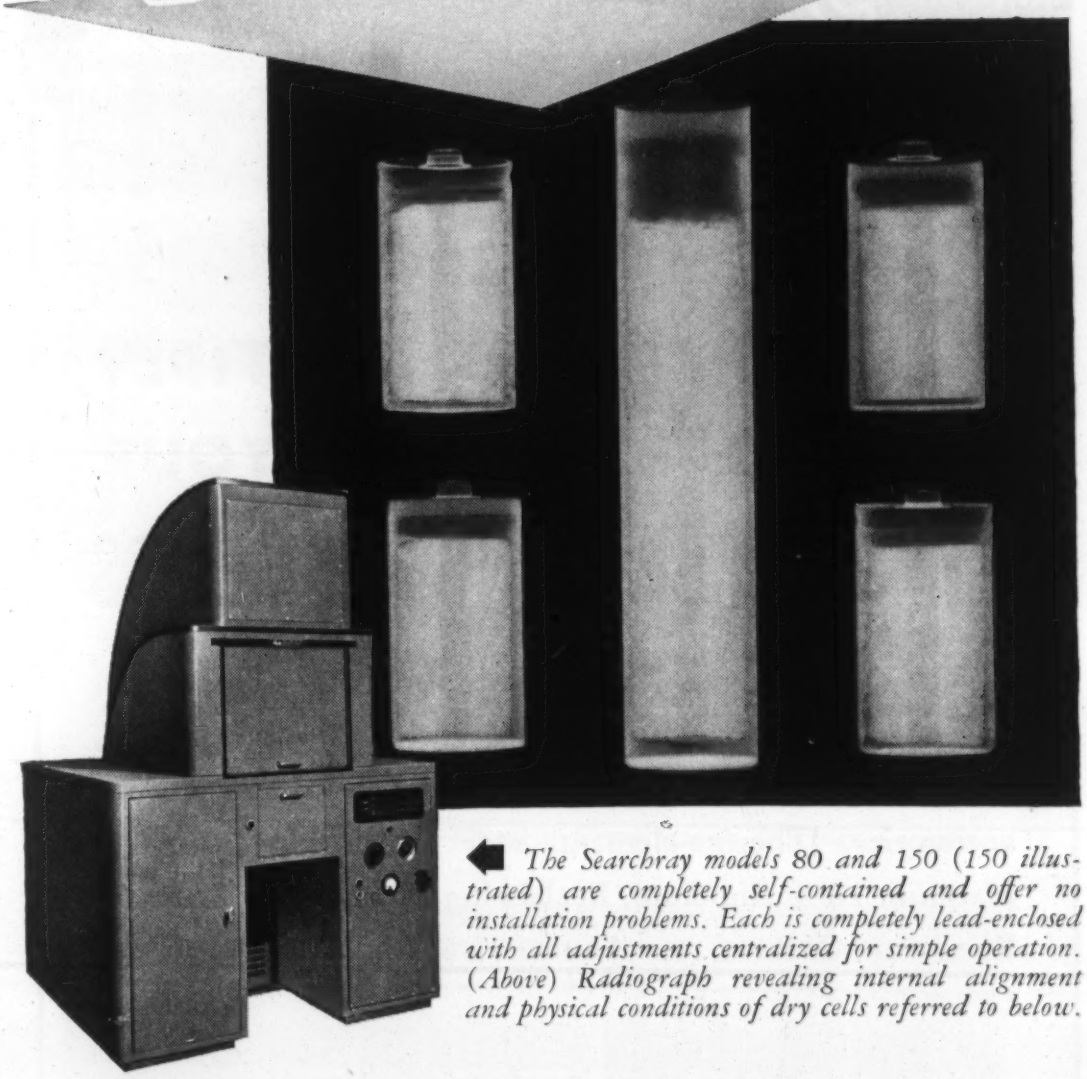
Resistance Welding Equipment. The basic types of resistance welders are described in Bulletin No. SP 345, a 10-page booklet of the *Federal Machine & Welder Co.* (O-108)

Arc Welder. A 20-200 amp. a.c. arc welder is described in a folding pocket-sized pamphlet of the *Hobart Bros. Co.* (O-109)
Oxyacetylene Methods in Steel Foundries. Air Reduction Sales Co. (O-39)
Tool Steel Electrodes. Alloy Rods Co. (O-18)
Arc Welding Stainless Sheet. Arcos Corp. (O-14)
Welding Positioners. Cullen-Friestedt Co. (O-44)
Plastics. E. I. Dupont de Nemours & Co., Inc. Electrochemicals Dept. (O-4)
Low Temperature Welding. Eutectic Welding Alloys, Inc. (O-8)
Arc Welders, Cranes, Etc. Harnischfeger Corp. (O-61)
Arc Welding. Lincoln Electric Co. (O-24)
Fabrication and Repair by Welding. Metal & Thermit Corp. (O-16)
Resistance Welding Applications. Progressive Welder Co. (O-42)
Projection Welder. Sciaky Brothers. (O-59)
Silver Brazing Alloy. Sherman & Co. (O-68)
Welding Electrodes. A. O. Smith Corp. (O-45)
Welding and Brazing Products. Stackpole Carbon Co. (O-89)
Hard Facing Alloys. Wall-Colmonoy Corp. (O-62)
Phos-Copper Brazing. Westinghouse Electric Corp. (O-72)

Cleaning and Pickling

Blast Cleaning Equipment. A new 16-page catalog, No. 264, describes the 60 by 96 Wheelabrator Tumblast made by the *American Foundry Equipment Co.* (P-41)

ANOTHER *"Inside View"* BY SEARCHRAY



◀ *The Searchray models 80 and 150 (150 illustrated) are completely self-contained and offer no installation problems. Each is completely lead-enclosed with all adjustments centralized for simple operation. (Above) Radiograph revealing internal alignment and physical conditions of dry cells referred to below.*

A DRY cell manufacturer formerly used a destructive method to spot check the quality of his products. Voltage and amperage tests were made. Cells were selected from the production batch and cut open to determine the position of the carbon center, paste level and the gassing condition. Yet, despite these careful checks, the method was unsatisfactory. Here's why!

1. Cutting open the cells disturbed the paste, the alignment of the carbon rod and the contour of the external cell wall.
2. Average inspection of 3,000 cells per week proved expensive.
3. Spot checking failed to reveal the condition of cells not selected for test.

By comparison, this is how SEARCHRAY helped—non-destructively.

The alignment of the carbon center, paste level and extent of gas pockets were made visible.

The homogeneity of the paste—important in life of cell—was readily determined.

SEARCHRAY determined the best time in manufacture to seal each cell.

The non-destructive method proved relatively inexpensive and profits formerly lost through destruction of cells were saved.

This is but one of the many examples of how industrial X-ray can aid in quality control and production methods. Let us show you how this non-destructive inspection tool can be utilized to your advantage in inspection and quality control.

NORELCO products include: Quartz crystals, cathode ray tubes, industrial and medical X-ray equipment, fine wire, diamond dies, tungsten and molybdenum products.

Norelco Reg. U. S. Pat. Off. ELECTRONIC PRODUCTS

NORTH AMERICAN PHILIPS COMPANY, Inc., 100 EAST 42ND STREET Dept. M-6, New York 17, N. Y.

TO MULTIPLY THE RANGE OF YOUR

PYROMETER INSTRUMENTS

ENGELHARD manufactures a complete range of assembled thermocouples consisting of thermo-elements with insulators, protection tubes, terminal heads, couplings and various accessories. Thermo-elements may be platinum vs. 90% platinum 10% Rhodium, Reclaiming Platinum vs. Platinum Rhodium, Chromel vs. Alumel, Iron vs. Constantan and Copper vs. Constantan.

Selection Is Important

ENGELHARD assembled Thermocouples insure maximum efficiency from their pyrometer instruments because each is made up from selected individual parts, chosen because of their ability to meet the requirements of a specific application.

Whether the atmosphere encountered is reducing, oxidizing or corrosive—the maximum temperatures likely to be encountered, probable quick changes in temperatures, how often the thermocouple will be removed or the lead wires disconnected—these are only a few of the main points in successful thermocouple selection.

Take your Thermocouple problems to Engelhard!

CHARLES ENGELHARD, INCORPORATED
90 CHESTNUT ST., NEWARK, NEW JERSEY

Metal Cleaning Supplies. In a new 24-page catalog, the cleaning and drawing compounds made by *Northwest Chemical Co.*, are described in detail. (P-40)

Cleaning Compound. A deodorizing, cleaning and disinfecting compound for industrial use is named "Tri-San," and is described in a pocket-sized, 20-page booklet published by *Oakite Products Co.* (P-42)

Vapor Degreasing. A chlorinated hydrocarbon nonflammable solvent called "Tromex" is described in an 8-page bulletin distributed by the *Westvaco Chlorine Products Corp.* (P-43)

Metal Cleaning Compounds. MacDermid, Inc. (P-13)

Cleaning Before Plating. Magnuson Products Corp. (P-6)

Plating and Finishing

Zinc Plating. Plating with a zinc fluorborate electrolyte is discussed in *General Chemical Company's* Technical Information Manual ZF-1. (Q-41)

Corrosion-Resistant Coating. Baker Synthetics, Inc. (Q-26)

Felt Wheels and Bobs. Divine Brothers Co. (Q-33)

Metal Finishing. Du-Lite Chemical Corp. (Q-22)

Protective Coating. Kaykote Div., Krans Research Laboratories. (Q-39)

Polishing and Buffing Booklet. Lea Mfg. Co. (Q-12)

Finishing Materials. McAleer Mfg. Co. (Q-31)

Radiant Heat Drying Lamps. Westinghouse Electric Corp. (Q-14)

Process Control Instruments

Moisture Detector. Instruments for the detection of moisture are described in a leaflet published by the *Colloid Equipment Co., Inc.* (R-42)

Dew Point Indicator. Model 8 Alnor precision dew point indicator is described in a 1-page leaflet of the *Illinois Testing Laboratories, Inc.* (R-43)

High-Speed Counter. The Model 69 Electronic Counter is the subject of a 4-page folder published by the *Potter Instrument Co.* (R-41)

Electric Control. Leeds & Northrup Co. (R-18)

Liquid Cooler. Niagara Blower Co. (R-26)

Testing and Inspection

Testing Machines. A series of bulletins dealing with instrument vibrators, tensile and compression testing machines, fatigue and

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rotating beam machines is available from the *Krouse Testing Machine Co.* (S-49)

X-Ray Usage. A new 4-page booklet (R 1023) entitled "X-Ray as a Foundry Control Tool", has been announced by the *North American Philips Co.* (S-50)

Testing Machines. Catalog 30 of the *Tinius Olsen Testing Machine Co.* covers the entire line of tension, compression and flexural testing machines made by this company. (S-48)

Industrial X-Ray Units. General Electric X-Ray Corp. (S-24)
Industrial X-Ray. Kelley-Koett Mfg. Co., Inc. (S-2)
Surface Finish Measurement. Physicists Research Co. (S-46)
Tensile Testing of Fine Wire. Scott Testers, Inc. (S-15)
Supersonic Inspection. Sperry Products, Inc. (S-41)

General Plant Equipment and Supplies

Oil Separator. A 4-page bulletin describes the Gale system of water cleaning and clarifying. *Gale Oil Separator Co., Inc.* (T-95)

Foot Switches. An 8-page catalog of manually operated foot switches and a 12-page catalog of master switches are both available from the *General Control Co.* (T-92)

Protective Clothing. Industrial protective clothing (rubber coats, aprons, gloves, etc.) is illustrated in a 10-page catalog of the *B. F. Goodrich Co.* (T-90)

Dust Collectors. The Ideal dust collector, is announced in a 4-page leaflet published by *Ideal Industries, Inc.* (T-94)

Conveyors. Overhead chain conveyors are described in a 20-page, illustrated booklet published by the *Lamson Corp.* (T-91)

Electric Meters. An 18-page, pocket size booklet (No. 17) describes the switchboard and portable ammeters, volt meters and watt meters manufactured by the *Norton Electrical Instrument Co.* (T-93)

Stainless Steel Valves. Alloy Steel Products Co. (T-73)
Corrosion-Resistant Ceramics. Atlas Mineral Products Co. (T-12)
Electric-Type Controllers. Bristol Co. (T-69)
Industrial Lubricant. Brooks Oil Co. (T-84)
Coated Abrasives. Clover Mfg. Co. (T-54)
Boring, Milling, Drilling and Tapping Machine. Defiance Machine Works, Inc. (T-50)
Soft Hammers. Gregory Tool & Mfg. Co. (T-79)
Automatic Clutch. Hardinge Co. (T-76)
Infra-Red Units. Miskella Infra-Red Co. (T-81)
Dust Collector. Pangborn Corp. (T-20)
Industrial Chemicals and Specialties. Pennsylvania Salt Mfg. Co. (T-11)
Dust Collector. U. S. Hoffman Machinery Corp., Filtration Div. (T-22)

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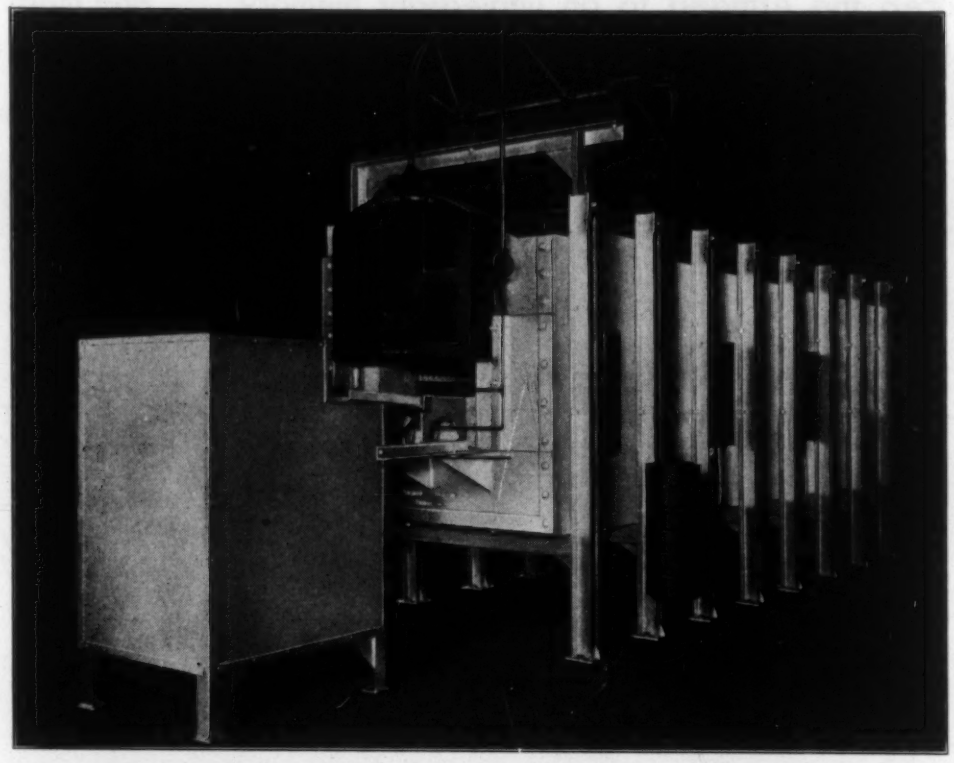
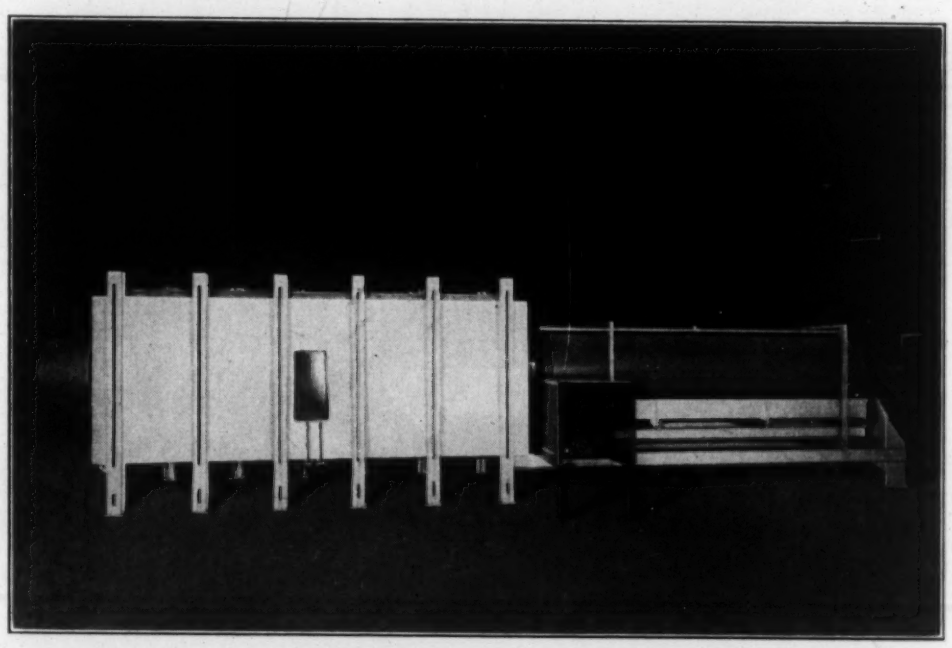
100% PAY LOAD
with "AMERICAN" Mechanized Furnaces



Model CP "AMERICAN" Electric Continuous Pusher Furnace



Model CRR "AMERICAN" Electric Rotary Retort Furnace

Mechanization is a definite trend in all types of heat-treatment. It facilitates work handling . . . gives closer control of Heating cycles . . . most adaptable to prepared atmospheres.

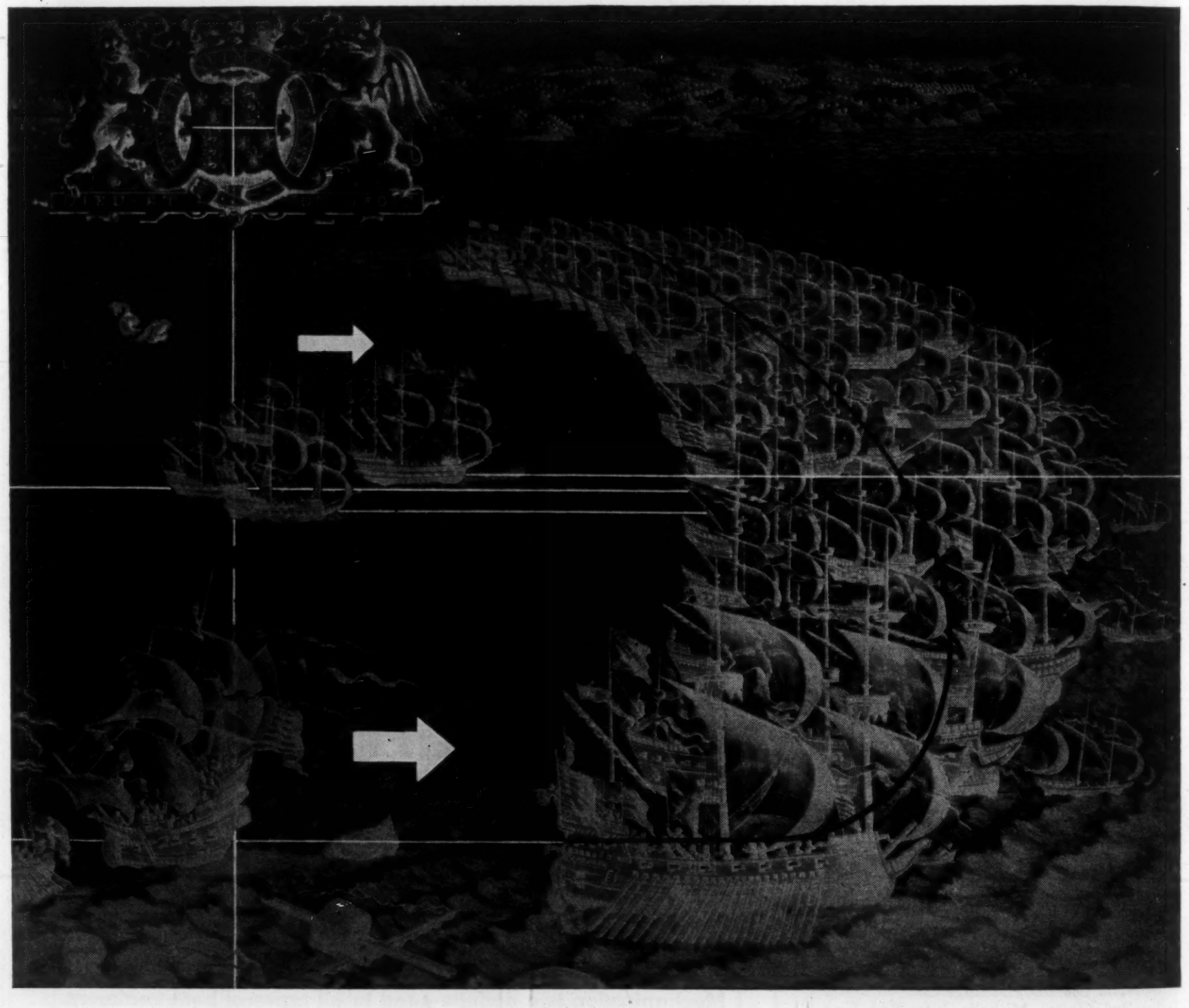
American Electric Furnace Company
29 Von Hillern St., Boston, Mass., U. S. A.

Industrial Furnaces for All Purposes

A LITTLE DOES A LOT

The Spanish built their colossal Armada to smother England by sheer weight. But Drake, with a scratch fleet of nondescript ships, and some brains, reduced the Armada to an unpleasant memory.

Not only in warfare can a little do a lot, intelligently applied. Today a little molybdenum is doing a lot to improve the strength and toughness of good cast iron. The foundry man's market is broadened and many a user's production headaches relieved. Practical working data is available on request.



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CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

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MOLY

Gas SERVICE

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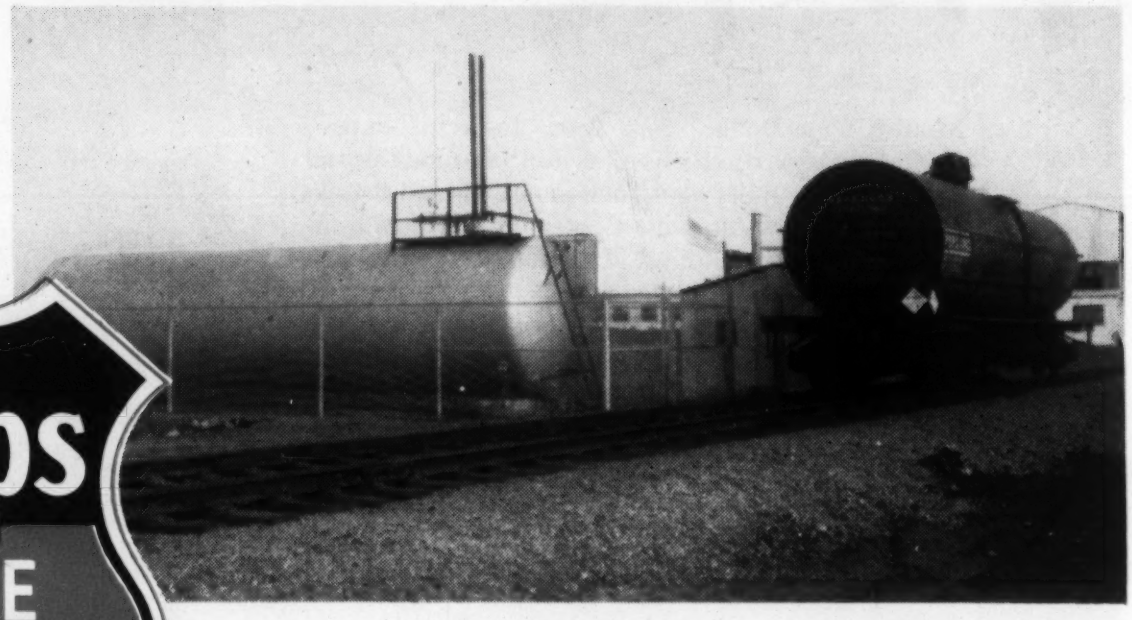

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BUTANE
PROPANE

Shipped and stored in concentrated liquid form, Phillips Propane is readily expanded to a gas . . . is piped to points of usage at the exact pressure required for your specific operations. The complete system is simple, automatic, and basically economical, operating for the exclusive use of your plant. Uniform composition . . . highest purity . . . and flexibility of control are other advantages assuring smooth and efficient production. Important too is dependability of adequate supply which day in, day out, winter and summer, is available from numerous sources and shipped by our huge fleet of tank cars and truck transports. Contact the Branch Office nearest you. A Phillips engineer will gladly furnish complete details.

PHILLIPS PETROLEUM COMPANY

Philgas Division

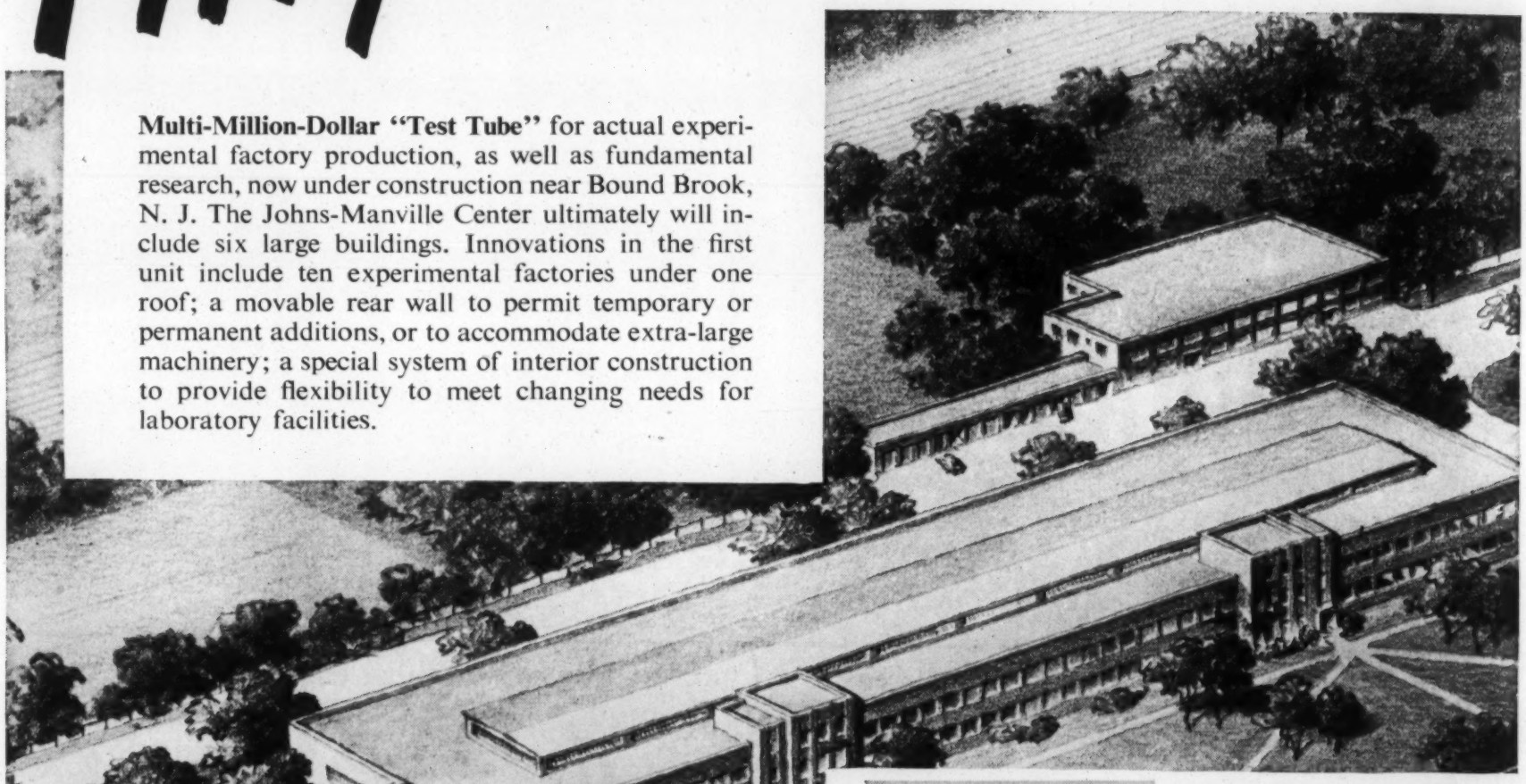
BARTLESVILLE, OKLAHOMA

Branch Offices in NEW YORK, CHICAGO, PHILADELPHIA, MILWAUKEE, DETROIT, ST. LOUIS, SHREVEPORT, AMARILLO, HIBBING, DENVER

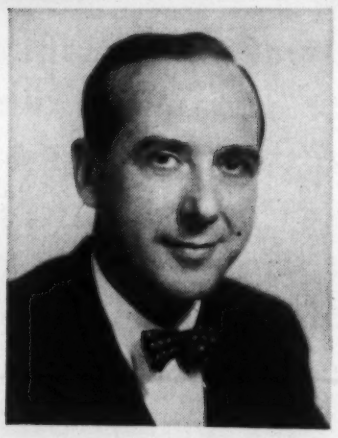
THE WORLD'S LARGEST MARKETER OF LIQUEFIED PETROLEUM GAS

Johns-Manville Announces

Fifty Million Dollar



Multi-Million-Dollar "Test Tube" for actual experimental factory production, as well as fundamental research, now under construction near Bound Brook, N. J. The Johns-Manville Center ultimately will include six large buildings. Innovations in the first unit include ten experimental factories under one roof; a movable rear wall to permit temporary or permanent additions, or to accommodate extra-large machinery; a special system of interior construction to provide flexibility to meet changing needs for laboratory facilities.



Dr. C. F. Rassweiler, Vice-Pres. of Johns-Manville Corporation in charge of research and development, states:

"We are living in an era of scientific improvement unparalleled in man's history. One single development stemming from social and economic needs can bring revolutionary changes throughout an industry. Today, we stand on the threshold of a new era, which has unlimited horizons for the development and improvement of new products for home and industry.

If this goal is to be achieved, some individual or group of individuals must have the imagination, courage and facilities to meet the challenge.

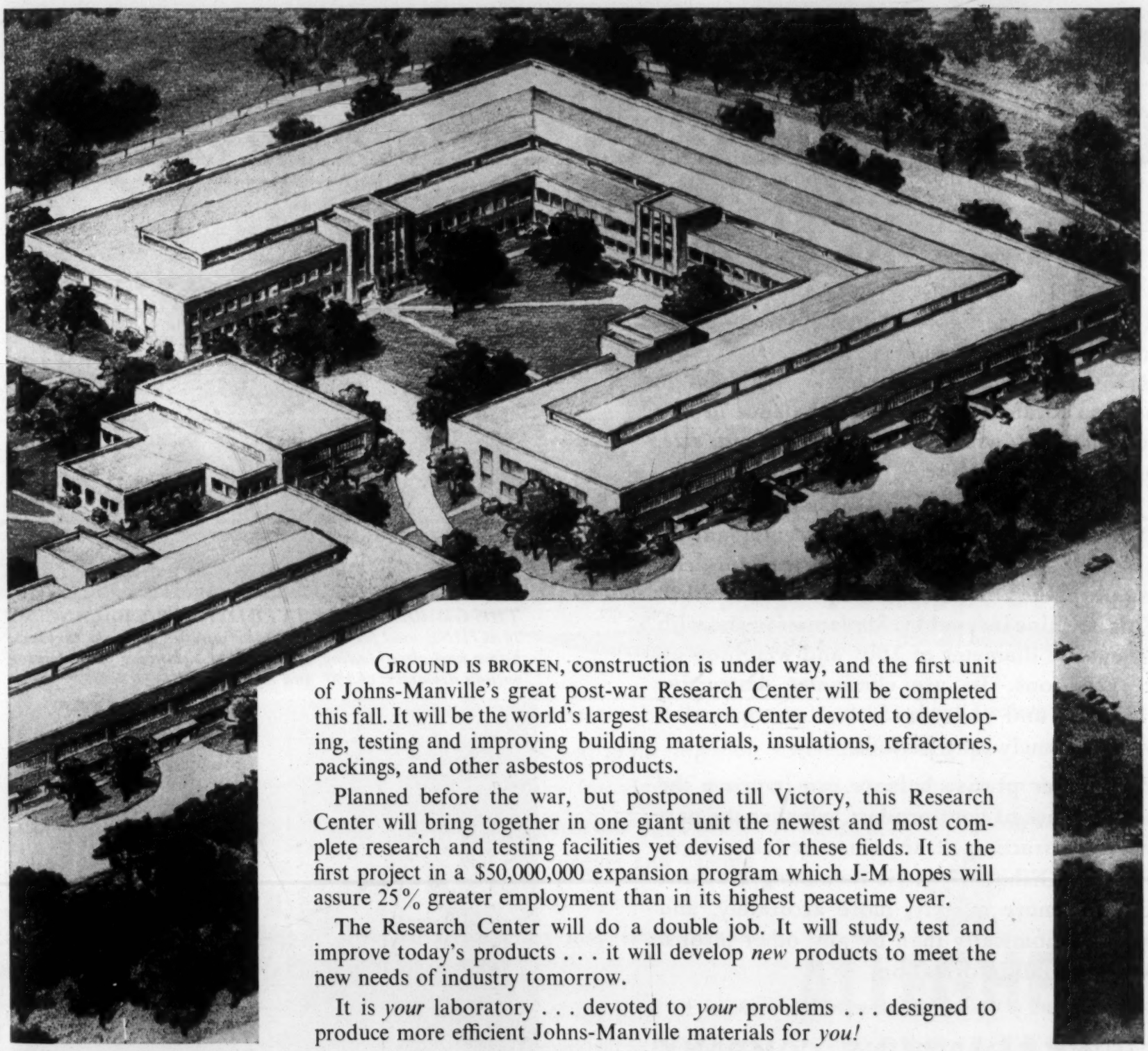
Johns-Manville has accepted this challenge and is now in the process of constructing the world's largest research laboratory devoted to service through science for better homes and greater industrial efficiency."

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville

Expansion Program

to include World's Largest Research Center for Building Materials, Insulations, and other Industrial Products



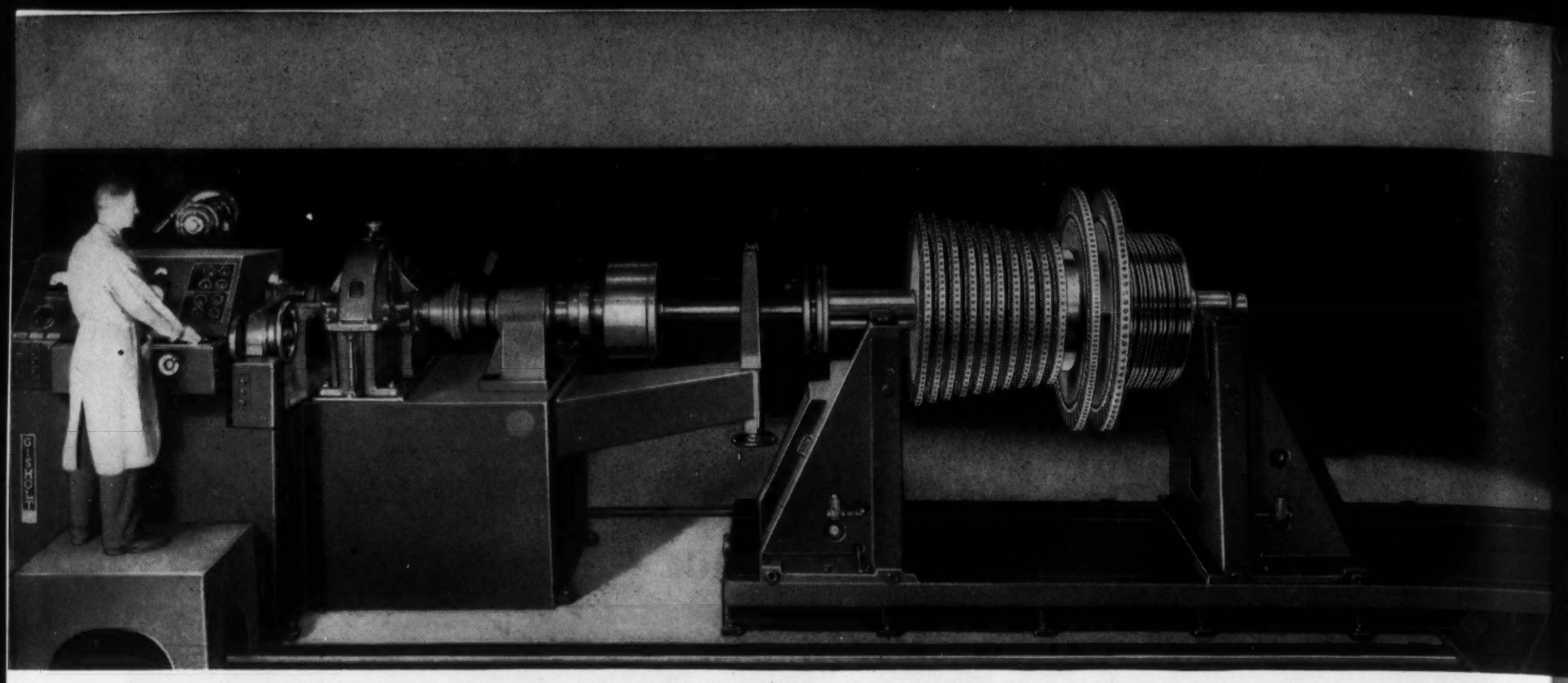
GROUND IS BROKEN, construction is under way, and the first unit of Johns-Manville's great post-war Research Center will be completed this fall. It will be the world's largest Research Center devoted to developing, testing and improving building materials, insulations, refractories, packings, and other asbestos products.

Planned before the war, but postponed till Victory, this Research Center will bring together in one giant unit the newest and most complete research and testing facilities yet devised for these fields. It is the first project in a $50,000,000 expansion program which J-M hopes will assure 25% greater employment than in its highest peacetime year.

The Research Center will do a double job. It will study, test and improve today's products . . . it will develop *new* products to meet the new needs of industry tomorrow.

It is *your* laboratory . . . devoted to *your* problems . . . designed to produce more efficient Johns-Manville materials for *you!*

Manufacturers of 1200 Products for Home and Industry



GISHOLT DYNETRICS* go to *any length* to eliminate vibration!

That's no mere figure of speech. It's literally true! For the basic principle of *Gisholt Dynetric Balancing Machines* is so flexible that it can be used to locate and measure unbalance in any rotating part, without regard for weight, size, or length of the piece.

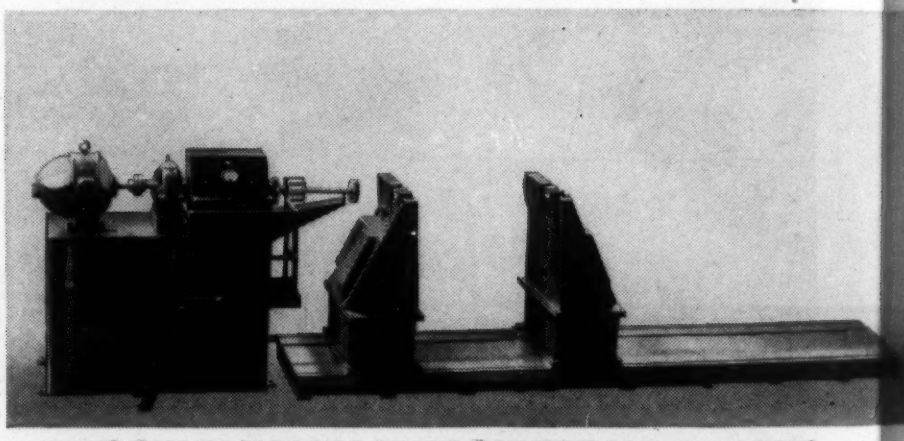
In the photo above, a Gisholt Floor Type Dynetric Balancing Machine is seen balancing a turbine spindle similar to those used for driving propellers of merchant ships and warships. This machine is capable of balancing parts with an outside diameter of 100″ and weighing up to 12½ tons. Its use eliminates destructive vibration and assures trouble-free operation over extremely long periods.

Wherever precise balance can improve the performance of your product, whether the part weighs a fraction of an ounce or many tons, there's a Gisholt Dynetric Balancing Machine to do it more quickly, more accurately, and more economically than by any other means. Write for full information.

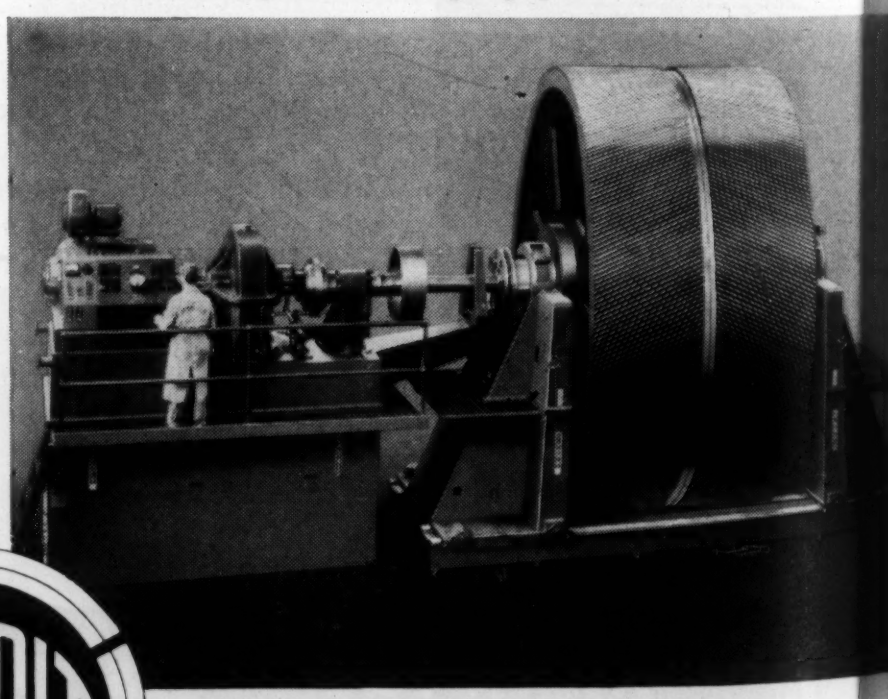
**A development of Westinghouse Research Laboratories.*

GISHOLT MACHINE COMPANY
1255 East Washington Avenue • Madison 3, Wis.

Look Ahead . . . Keep Ahead
. . . With Gisholt



THIS GISHOLT FLOOR TYPE DYNETRIC BALANCING MACHINE used for balancing the spindles of steam turbines, before and after blading, is capable of balancing parts having outside diameters of 150″ and weighing up to 30 tons.



This 50-ton herringbone gear used in transmitting power to the propeller of a large battleship is balanced on another Gisholt Floor Type Dynetric.

GISHOLT

TURRET LATHES • AUTOMATIC LATHES • SUPERFINISHERS • BALANCERS • SPECIAL MACHINES

WE PRODUCE THEM IN TOOL, DIE, STAINLESS SAE, OR NE STEELS—*Any Application!*

WRITE FOR THIS BOOKLET

It contains details of the complete line of FCC Smooth Hammered Forgings of Allegheny Ludlum Tool and Stainless Steels, FCC Tool Steels, SAE Steels, NE Steels; it describes also other important FCC Tool Steel Specialties that may suggest money-saving ideas.

Get your copy—write for it today.

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W & D 9641-C

BROAD experience before and during the war in forging tool and die blanks for almost every conceivable hot-work application has fitted our Forging and Casting Division to deal expertly with any problems that may arise in this exacting field.

Regardless of the kind of work to be done or material to be worked we are equipped to furnish you a correctly made forging of hot-work steel that will give you the utmost in effective performance.

Any Allegheny Ludlum field representative can give you further particulars; or write for the booklet today. (See description at left.)

ALLEGHENY LUDLUM STEEL CORPORATION
Forging and Casting Division
DETROIT 20, MICHIGAN

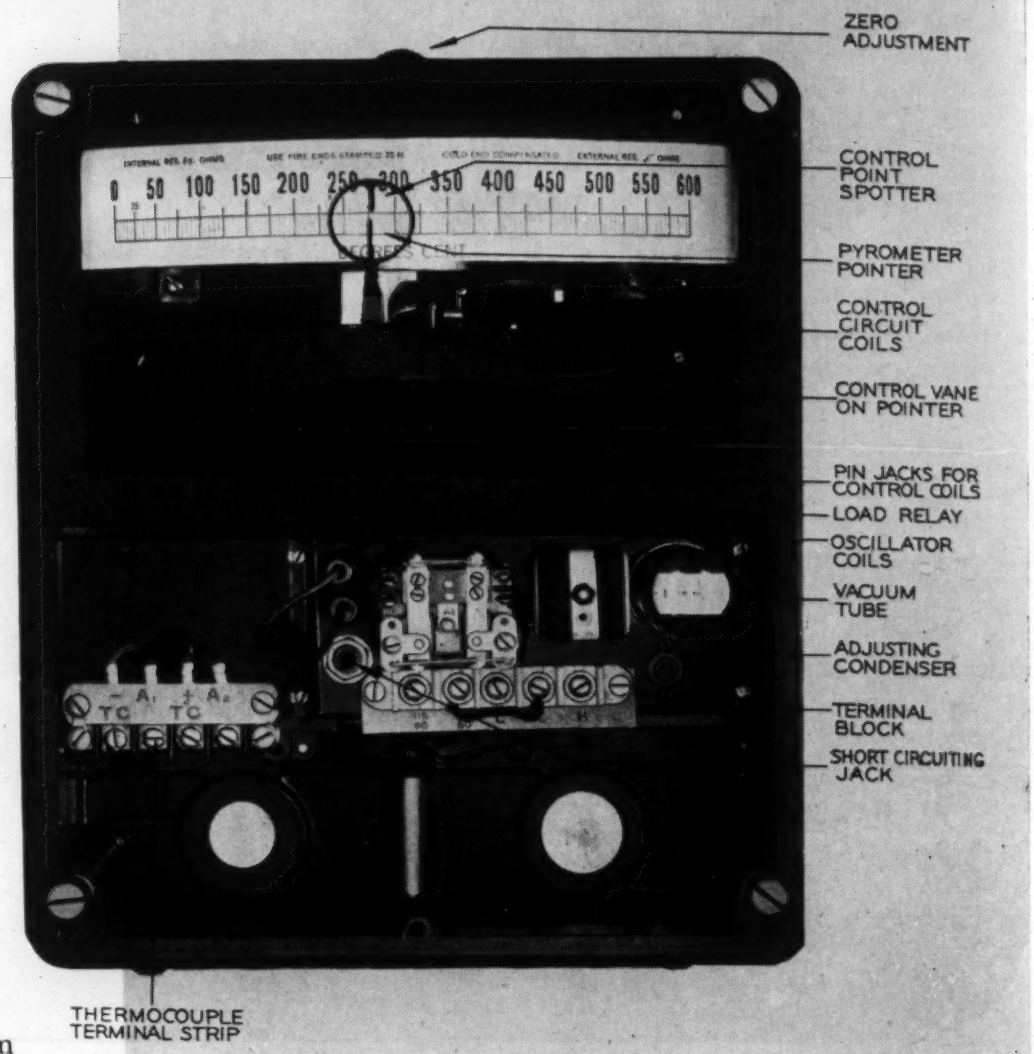
IN "HOT SPOTS"

. . . Electrons are "Quicker on the Trigger"

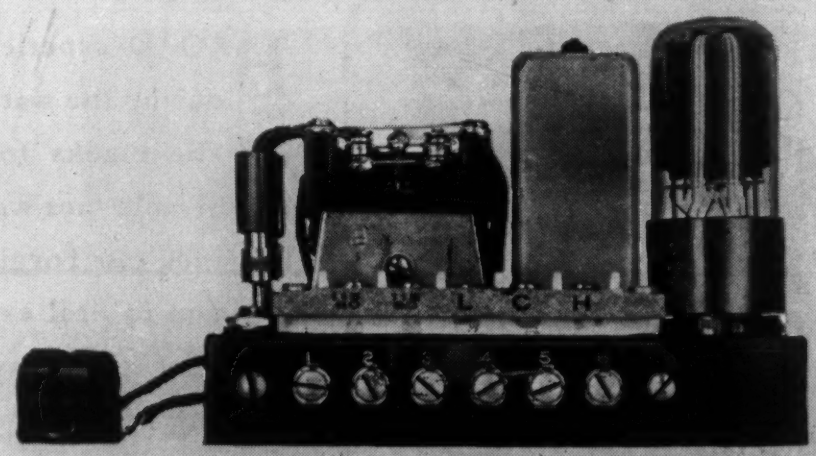
Bristol's Free-Vane Electronic Pyrometer Controller, Model E486, is an up-to-the-minute development for closer automatic temperature-control up to 3600°F. In widespread use on heat-treating and other industrial furnaces, ovens and kilns, this modern, high-quality instrument is simple in construction and positive in action.

CONTROL IS ENTIRELY ELECTRONIC

All moving parts, such as motors, depressor bars, toggle switches and contacts are eliminated from the control circuit. This means long, trouble-free service without maintenance, oiling or daily adjusting. The control unit uses a single high-output vacuum tube; a simple variable-condenser adjustment compensates for normal variations in tube characteristics. Snap-action current change in the relay coil provides extreme sensitivity of control, yet variations in temperature or humidity do not affect accuracy. Measuring elements are the standard, highly accurate types regularly used in Bristol Indicating Millivoltmeter Instruments. Since the pyrometer pointer moves without mechanical engagement, an instant, accurate indication is assured at all times . . . Detailed information is contained in Bulletin PB1217. Address THE BRISTOL COMPANY, 162 Bristol Road, Waterbury 91, Connecticut. (The Bristol Co. of Canada, Ltd., Toronto, Ont. Bristol's Instrument Co., Ltd., London, N.W. 10, England.)



Bristol's Electronic Pyrometer Controller consists of two separate units: the pyrometer unit which measures and indicates the temperature, and the control circuit which opens and closes a relay in the load circuit that regulates the fuel supply. There is no mechanical or electrical connection whatever between the two.



Control unit complete with relay, control coils, vacuum tube — *and not a single moving part.*

BRISTOL

... Gives YOU the Most from Heat

AUTOMATIC CONTROLLING AND RECORDING INSTRUMENTS

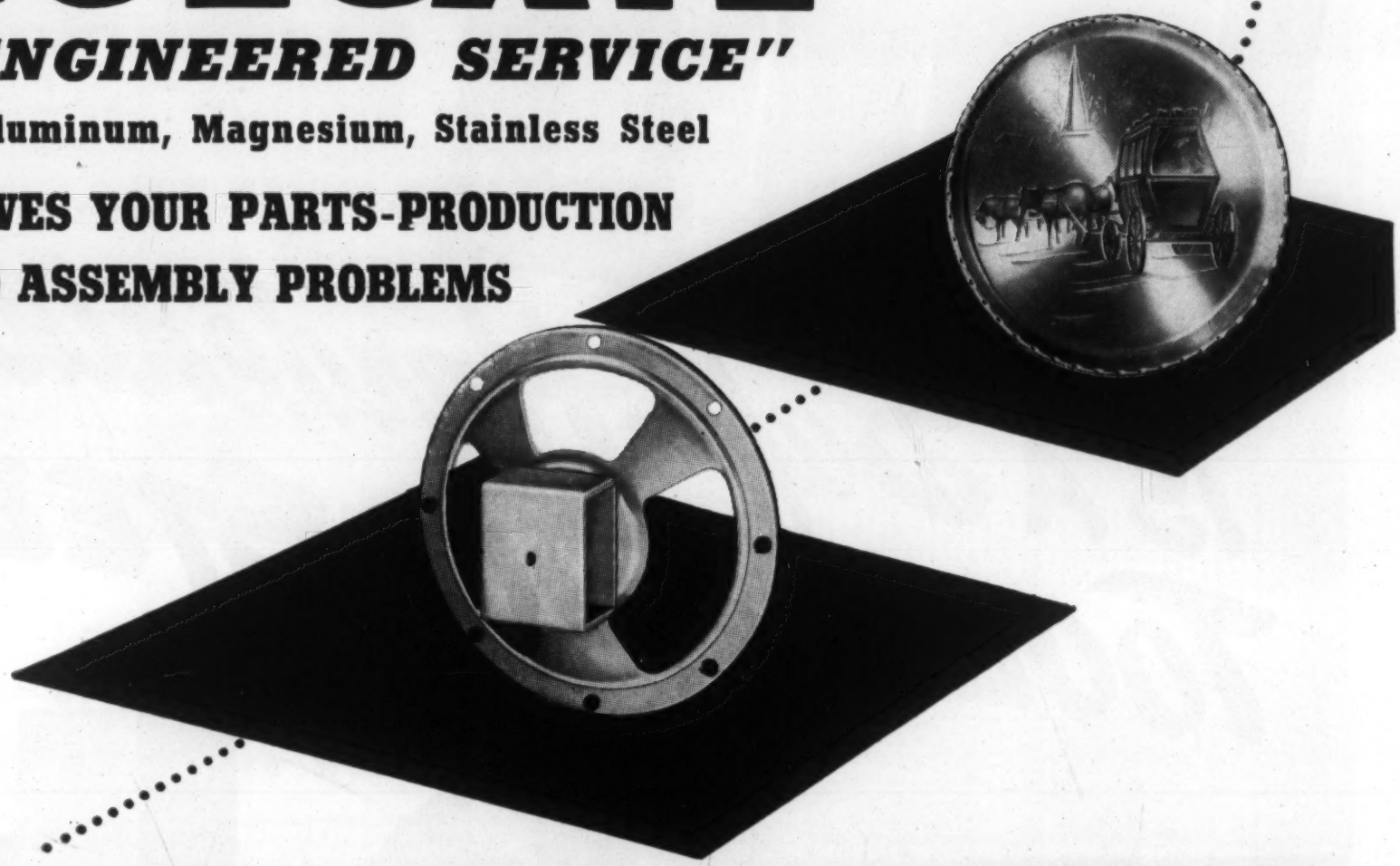
Coasters or Speakers .....

COLGATE

"ENGINEERED SERVICE"

in Aluminum, Magnesium, Stainless Steel

SOLVES YOUR PARTS-PRODUCTION AND ASSEMBLY PROBLEMS



If your new or improved consumer product requires the mass-production techniques and specialized COLGATE facilities that produce these aluminum coasters by the millions . . . or if your industrial product calls for split-thousands accuracy, in large or small quantities, such as required in this radio speaker in order to assure perfect fitting and absolute interchangeability of the stamped, blanked, and formed chassis — *then it will be to your advantage to consult with COLGATE!*

The extreme range of specifications and the diverse use of these products are an excellent indication of the versatility and the broad range af scope offered by COLGATE'S "ENGINEERED SERVICE" to manufacturers of consumer and industrial products. From the initial rough-idea stage to final assembly, this unique and comprehensive service provides advance design and engineering aid in the form of *preliminary* conferences that solve your problems *before* designs have been started, also after blueprints have been prepared.

COLGATE'S sales-minded designers and engineers will help develop your new product ideas, improve old products by substituting Aluminum, Magnesium, or Stainless Steel for other materials and give your product these sales-building features — *lighter weight, added beauty, increased strength and durability, resistance to corrosion, thermal and electrical conductivity, improved product appearance and performance.*

COLGATE can help solve your problems and function as your "branch factory" by providing ample space, supplying the specialized skills and know-how for fast, economical fabrication and assembling of precision parts — and get your product to market faster by meeting delivery dates with dependable regularity. For immediate action wire or write, complete confidence assured, no obligation.

Completely centralized facilities include our own *tool* and *die shop* in addition to Hydraulic Presses 10 to 750 tons, and Mechanical Presses 2½ to 200 tons.

STAMPING • FORMING • DRAWING
WELDING • FINISHING • ASSEMBLING

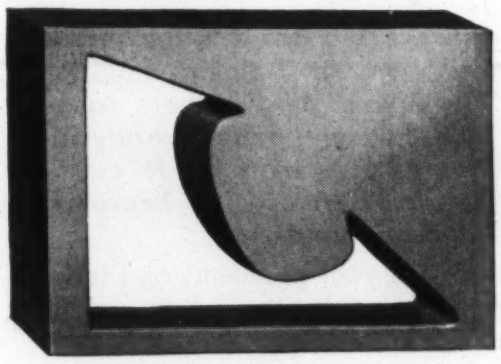
COLGATE *Aircraft Corporation*

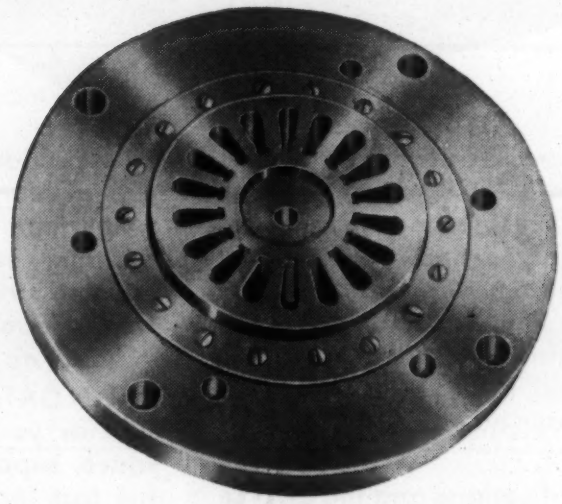
AMITYVILLE, LONG ISLAND, NEW YORK

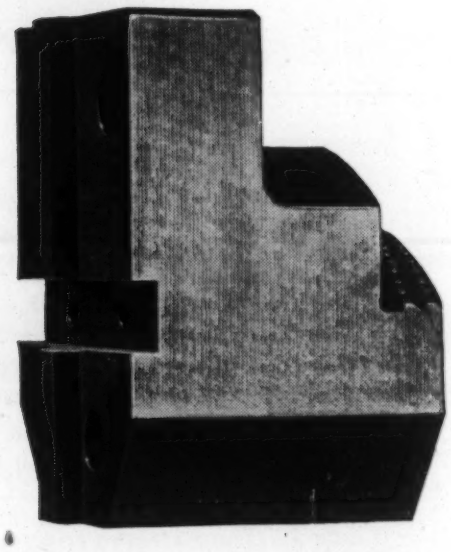
LIGHT METAL PRODUCTS

BTR

IS A Safe-Hardening TOOL and DIE STEEL







A steel that hardens safely—that quenches without cracking—is like money in the bank to the tool- and die-maker. That's why Bethlehem Tool Room (BTR) is the recognized leader in its field.

When there are drastic dimensional changes in the die or punch—when there are sharp, angular corners or round corners with small radii—when there are many holes separated by thin webs—play safe and insist on BTR.

Its safe-hardening characteristics are due in part to the following reasons:

(1) Balanced analysis of manganese, chrome, tungsten, and vanadium.

(2) Ability to oil-harden at relatively low temperatures.

Here is a steel that holds its size and shape in the heat-treating process. You'll find, too, that in the ideal quenching and tempering range, it hardens to a Rockwell C of 62-63. Moreover, it is easy to machine and is high in both wear- and shock-resistance.

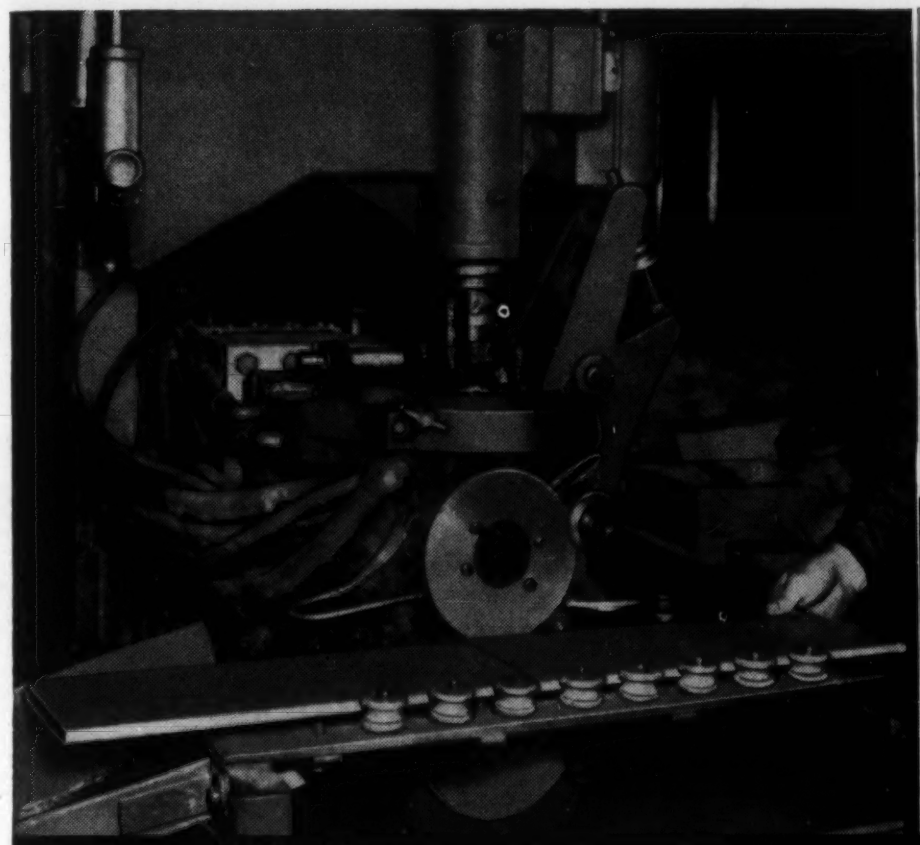
BTR is an old, reliable performer. To minimize cracking dangers, always make sure that it's stocked in your tool room.

TYPICAL ANALYSIS:

C	Mn	Si	Cr	W	V
0.90	1.20	0.30	0.50	0.50	0.20

BETHLEHEM STEEL

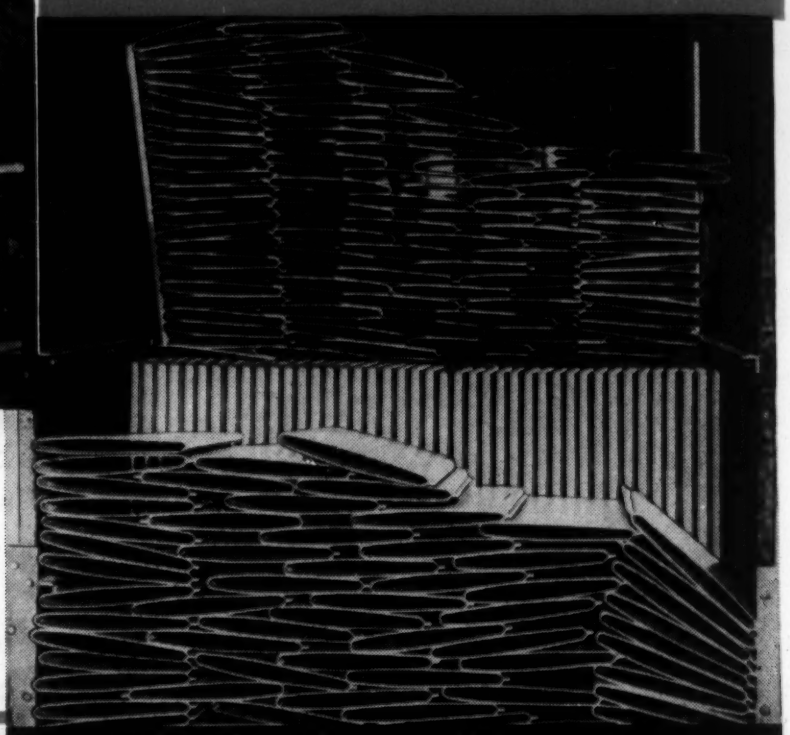
BETHLEHEM TOOL ROOM . . . one of Bethlehem's *Big 8* Tool Steels



Welding tube sections at the Reznor plant

1500% INCREASE in OUTPUT

. . . made possible by electronically controlled resistance welding . . .



Eight of these tubes are welded every minute

Heat-exchanger tubes are now produced by the Reznor Manufacturing Co., Mercer, Pa., at *16 times* the former rate, using seam welding.

While one operator could produce only *30* tubes an hour by gas welding, he can now complete *480*—or a total of 45,000 inches of weld.

This is just one striking example of the boosts in output possible with seam welding.

Why ELECTRONIC Control Was Chosen

Basically a fast process, seam welding is speeded up even more by electronic control. With this type of control it is possible to interrupt the welding current consistently up to 1800 times in a *single minute*.

Equally important is the fact that electronic seam-welder control, with its synchronous-precision timing, helps assure high-quality welds.

Electronic control is quiet operating, too. The welding current is controlled by noiseless electronic tubes. And because there are no contacts to replace, maintenance cost is low.

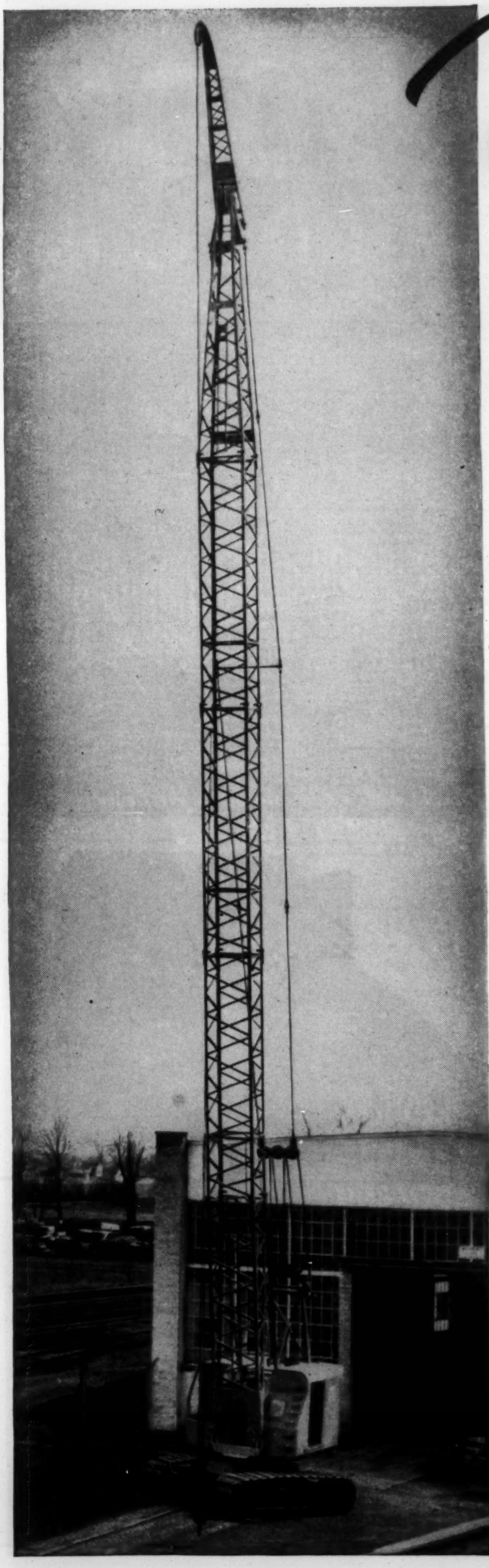
If you'd like more information about electronic seam-welder control, ask our local office for a copy of Bulletin GEA-4220. Our engineers will be glad to help you with your application. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

REDUCED KVA DEMAND

This electronic seam-welder panel used in the Reznor plant offers an additional advantage—it is designed for use with series capacitors to provide power-factor correction. This combination makes possible a material reduction in demand on the power supply—an important saving in all industries.

G-E RESISTANCE WELDING CONTROL

GENERAL ELECTRIC



Yoloy

Eliminates dead weight .... increases pay load

LOW-ALLOY high-tensile steel plays an essential part in the well-balanced design of this crane, built by a Bay City, Michigan shovel manufacturer. Use of Yoloy steel in the boom and jib enables the crane not only to get longer reach, but also to handle greater pay loads. The boom is slender and unusually light-weight, yet is extremely strong, tough and corrosion resistant.

This is one of the many applications for Youngstown's Yoloy, a nickel-copper alloy steel of high corrosion resistance, high strength, outstanding toughness and weldability.

Yoloy is an ideal constructional steel permitting maximum weight savings which can quickly result in increased revenue from bigger pay loads. Yoloy's remarkable resistance to corrosion and fatigue recommends it for equipment that must perform in severe service.

Yoloy steel is now available in plates, sheets, strip, shapes, wire, seamless and electric weld pipe.

By building this boom entirely of Yoloy steel, the crane manufacturer was able to reduce its bulk and weight, making it stronger and longer than was possible with steels formerly used for booms.

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FOR PLANT OPERATIONS THAT INCLUDE

SHOP RECORDS PROVE BOWSER-KOLD-HOLD UNITS AID PRODUCTION 3 WAYS

- **INCREASE OUTPUT**
- **LOWER PIECE COSTS**
- **IMPROVE QUALITY**

SHRINK-FIT ASSEMBLY FASTER THAN PRESS-FIT

Easier, quicker, safer because no press is needed. Distortion and damage is eliminated. Especially profitable for all sleeve, bushing and insert operations.

CUTTING TOOLS, STANDARD CRIB TOOLS & GAUGES WEAR LONGER WITH COLD TREATING

Bowser-Kold-Hold treating after standard treatment results in longer life and Rockwell "C" 63-65 hardness. Complete stability without "growth" improves gauge quality, eliminates distortion.

SHRINK FITTING
AND FINE ASSEMBLY WORK
HARDENING
DIES • TOOLS • GAUGES
STABILIZING
METALS . . . . . .

BOWSER INDUSTRIAL CHILLING UNITS ARE AVAILABLE NOW

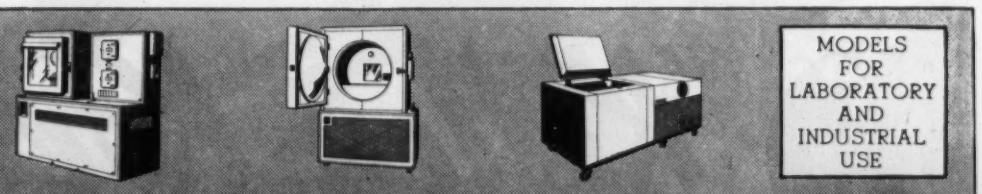
Temperatures
AS LOW AS 150° BELOW ZERO!

–150° F.

Requests for special information receive immediate attention. Bowser Refrigeration Div. engineers will assist in laboratory, testing or production problems.

Bowser-Kold-Hold provides lower temperatures (to –150° F.) than conventional units. Furnished standard in 5 and 11 cu. ft. capacities for rapid delivery. Operating costs of Bowser mechanical chilling units are lower than dry ice or liquid air chilling equipment. Write for literature and prices today.

BOWSER ESTABLISHED 1885



MODELS FOR LABORATORY AND INDUSTRIAL USE

BOWSER, INC. • REFRIGERATION DIVISION • TERRYVILLE, CONN.

IN CANADA, S. F. BOWSER, LTD. • 183 GEORGE ST. • TORONTO, ONTARIO

The KELEKET 150 KV Industrial Unit

The above is a picture of castings reproduced from a radiograph taken with this KELEKET 150 KV unit.

The unit was designed by this 46 year old X-ray company to meet the special requirements of industry. It makes inspection by X-ray extremely simple. Your present employees can be trained to produce clear, sharp radiographs that will instantly show any internal flaws in either steel, aluminum, copper, brass or bronze.

The 5-B rail-mounted tubestand illustrated is very flexible. It can be used over bench or conveyor belt and the tube can be readily moved vertically or horizontally for quick positioning.

● War industry learned the great value of inspection by X-ray. Now, peace time producers are profiting by this rich experience.

Radiography not only detects flaws inside castings—but also serves as a reliable guide in checking for faulty dies and molds. It leads to analysis, correction, uniformity and improved quality throughout.

Even with the most exacting technics and other precautions, unseen flaws are unavoidable. Internal porosity, cracks and holes are never detected by surface examination.

Spot checking by destruction is often resorted to. But this is costly and at best—haphazard. Radiography is the acknowledged sure way. And it is being generally adopted by cautious industry in these days of reconversion as a required tool for economical production.

This extra precaution results in extra advantages. You avoid rejects. You save expensive machining of faulty castings. Production is speeded up. Costs are reduced and profits increased.

KELEKET Engineers will be glad to show you how you can adapt X-ray quality control to your individual problem. Ask the KELEKET office in your city or write to us.

THE Kelley-Koett Manufacturing Co.

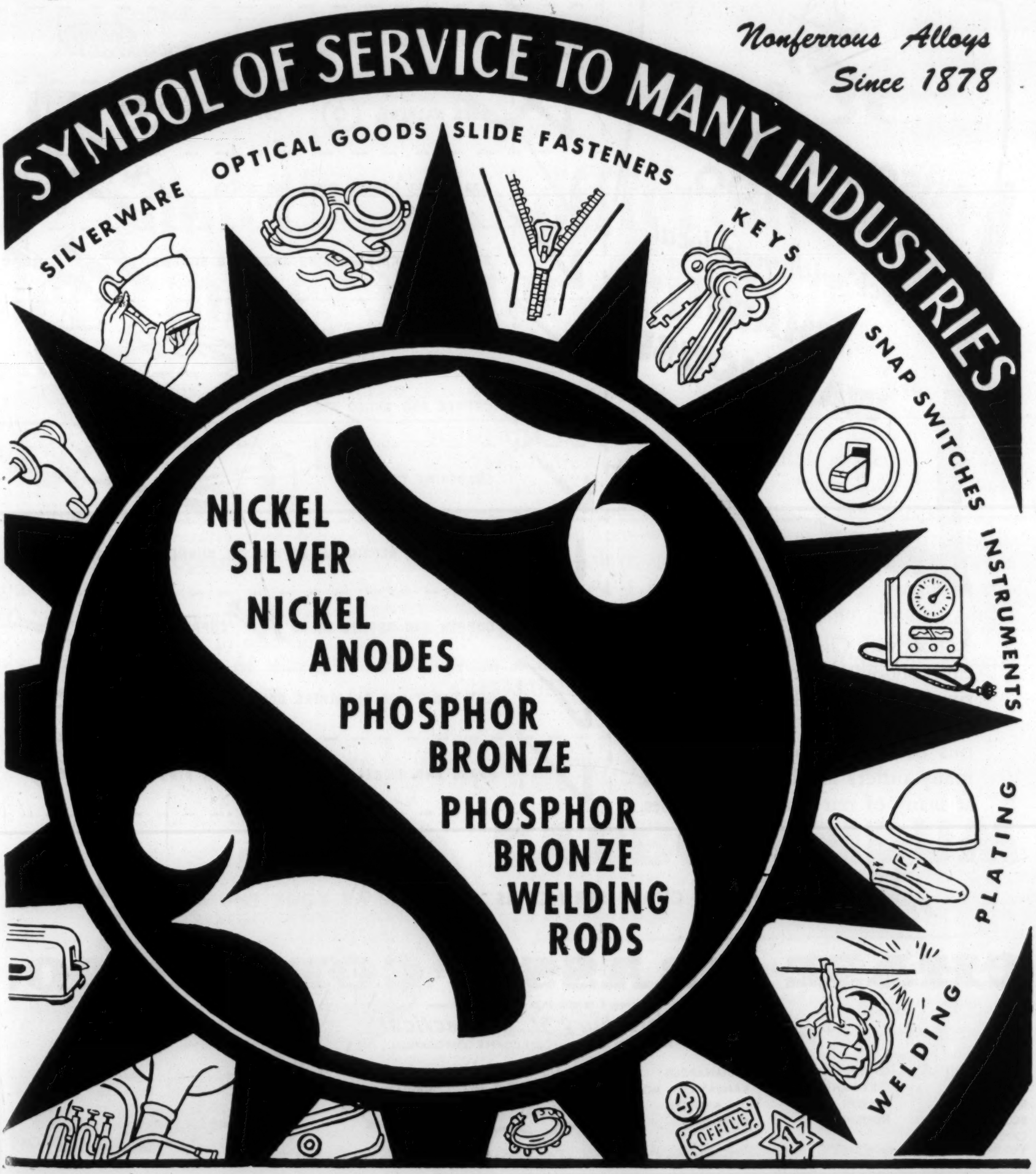
KELEKET-THE FINEST TRADITION IN X-RAY 2206 WEST FOURTH ST., COVINGTON, KY.

THE SEYMOUR MANUFACTURING CO.

SEYMOUR, CONNECTICUT

In the 65 years that "Seymour" has manufactured nonferrous alloys, service has reached practically every metal working industry. In this period, three major wars have drawn heavily upon and greatly developed the usefulness of these alloys. Purchasing Agents should revise their records to include them as major elements of product design, and study their characteristics so as to be able to make accurate recommendations to engineering and mechanical departments. Glad to furnish information promptly.

Nonferrous Alloys Since 1878



For these

MISCELLANEOUS ITEMS, TOO

check with your local

CHASE WAREHOUSE

Check with Chase before you spend time shopping around for copper rivets and burs, soldering irons and brass cotter pins. These miscellaneous brass and copper items and many others are carried in stock at many of our Chase warehouses.

- ✓ COPPER HAMMERS
- ✓ BEARING BRONZE, SILICON BRONZE BOLTS
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- ✓ BRASS AND BRONZE COTTER PINS
- ✓ BRONZE SASH CHAIN
- ✓ LOCK WASHERS, COPPER SHOT
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- ✓ BRASS AND NICKEL-PLATED ESCUTCHEON PINS

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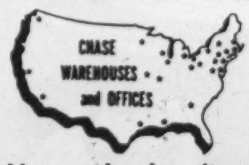

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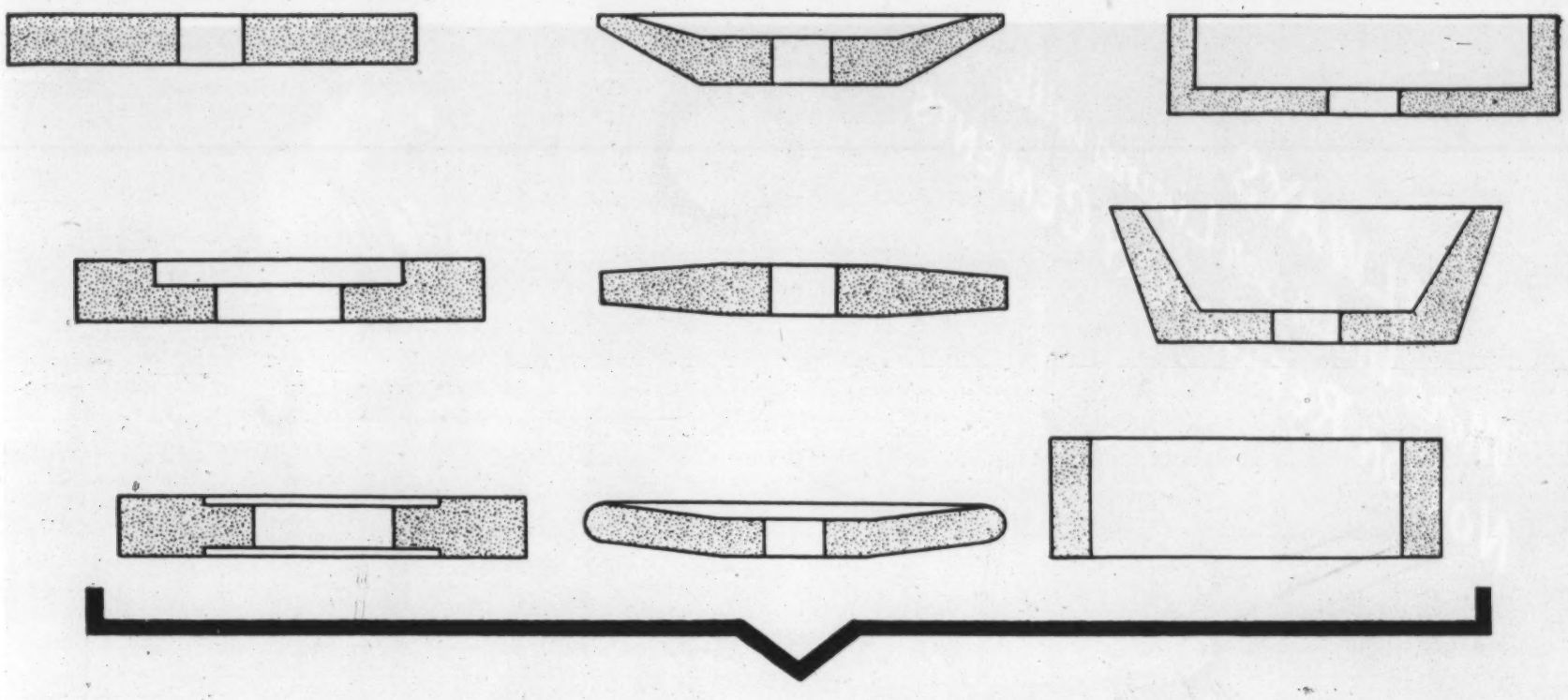
This is the Chase Network—handiest way to buy brass



Sometimes a different shape determines better grinding

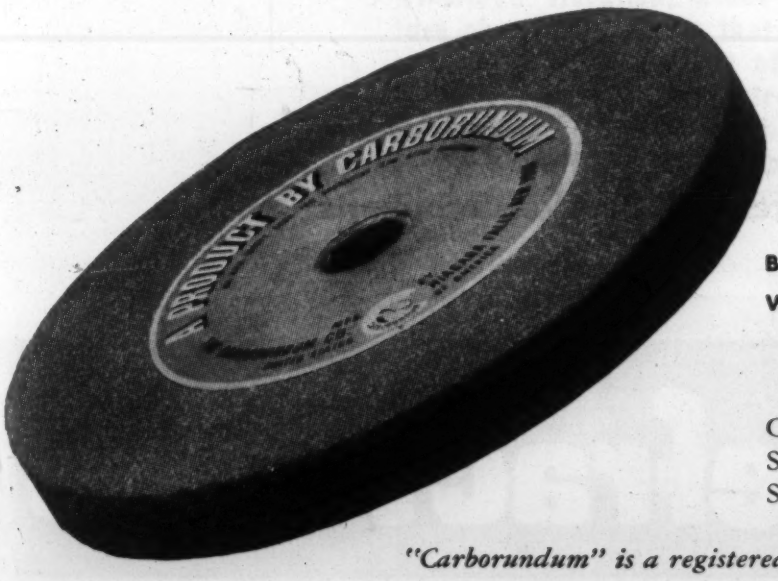
In terms of grinding wheel life, as well as efficiency and economy—the wheel shape selected for a specific operation is worth careful consideration. This is equally true for both production operations and tool-room grinding.

To help you check your grinding operations . . . to assist in selecting the best combination of shape, grit, grade and bond, follow the simple plan of many top notch production men. Consult with your CARBORUNDUM salesman or our distributor's representative. Many customers consider his opinions of real, practical value. His suggestions are based on a knowledge of latest abrasive developments . . . supported by daily experience with plenty of on-the-job grinding applications.

If the problem is unusually difficult, the CARBORUNDUM representative may call in an Abrasive Engineer for consultation. Both representative and Abrasive Engineer have available to them the facilities and resources of the world's most noted abrasive laboratories.

Through this single practice, of calling in CARBORUNDUM, you can be sure of getting maximum efficiency from your grinding wheels and other abrasive products. The Carborundum Company, Niagara Falls, New York.

A good rule for good grinding . . . **CALL IN**



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for:

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Lapping
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Finishing

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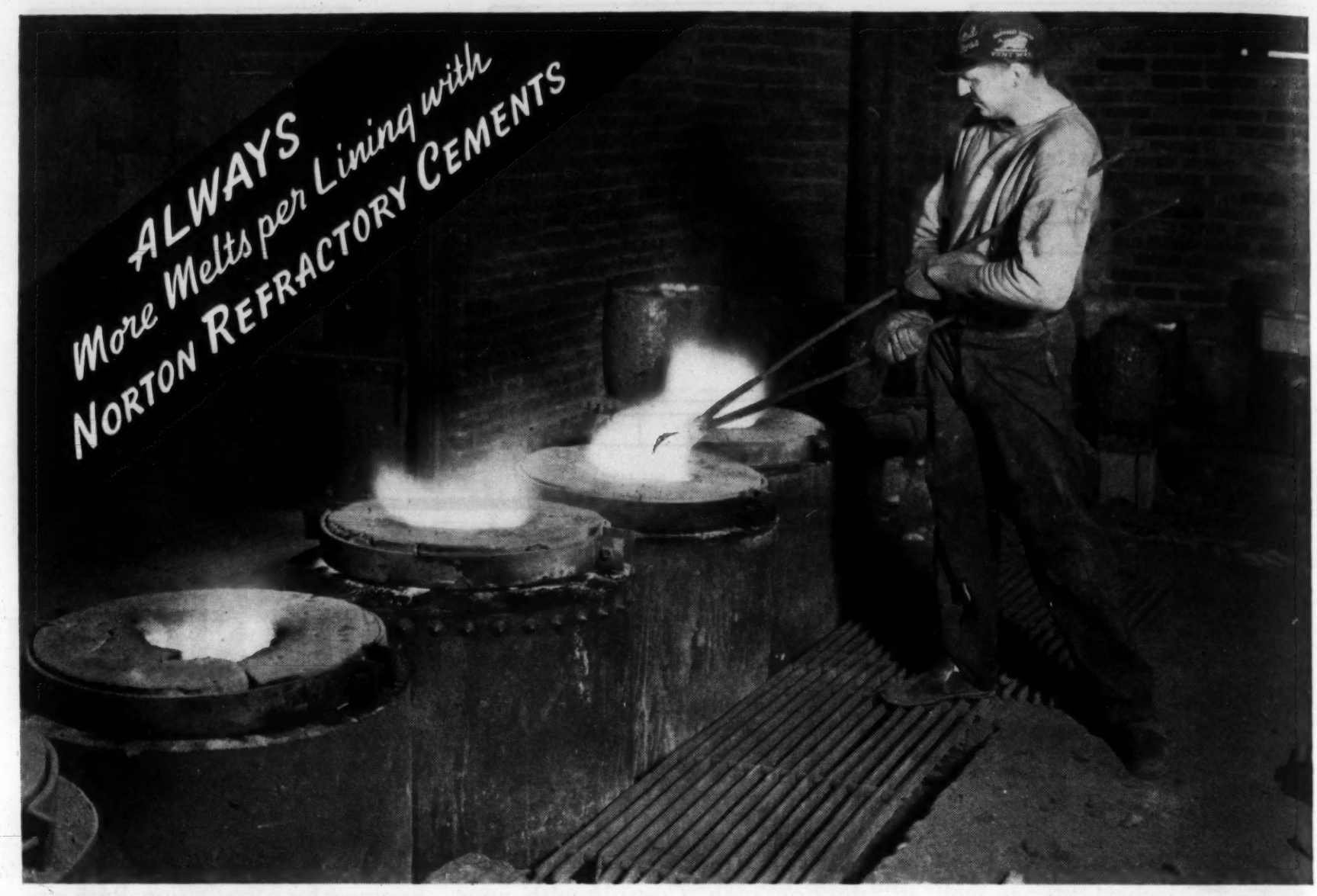

Norton refractory cements and pre-fired shapes are made for all non-ferrous metal-melting applications in pit furnaces, direct arc type rocking furnaces, induction and high frequency furnaces. ALUNDUM (fused Al_2O_3), CRYSTOLON (SiC) and fused Magnesia are used in the mixtures which are successfully employed for melting aluminum, copper alloys and nickel-chromium, nickel-silver, copper-nickel and cadmium-bronze alloys.

NORTON COMPANY • Worcester 6, Massachusetts

Norton Longer Lasting Refractories

EASY-FLO BRAZING

A typical steel stamping job in which EASY-FLO brazing is giving one auto manufacturer these benefits — high strength, no warpage, less finishing, fast production, low cost.

keeps pace with the ever-growing use of STAMPINGS

Hundreds of parts and products are now fabricated from stampings and the number is steadily multiplying. As an ideal method of joining stampings, EASY-FLO brazing has played a leading part in this development right from the start.

And why is EASY-FLO brazing ideal for joining stampings? Because EASY-FLO makes joints fully equal to the stamping itself in strength, and in ductility to withstand vibration, shock and temperature changes — joints that are liquid and gas tight — joints that offer high electrical conductivity and strong resistance to corrosion. And in the making of these joints EASY-FLO's low temperature makes it easy to protect thin metals from heat damage.

Of equal importance, this combination of properties makes EASY-FLO brazing fast and surprisingly low in cost. With modern heating equipment and production methods, reliably brazed parts are turned out at amazing production rates —and by easily trained operators.

GET COMPLETE DETAILS IN BULLETIN 12-A

All the EASY-FLO facts mentioned in preceding paragraphs are fully explained in this bulletin. They're important to every designer and manufacturer of metal products. A copy of Bulletin 12-A is yours for the asking. Write for yours today.

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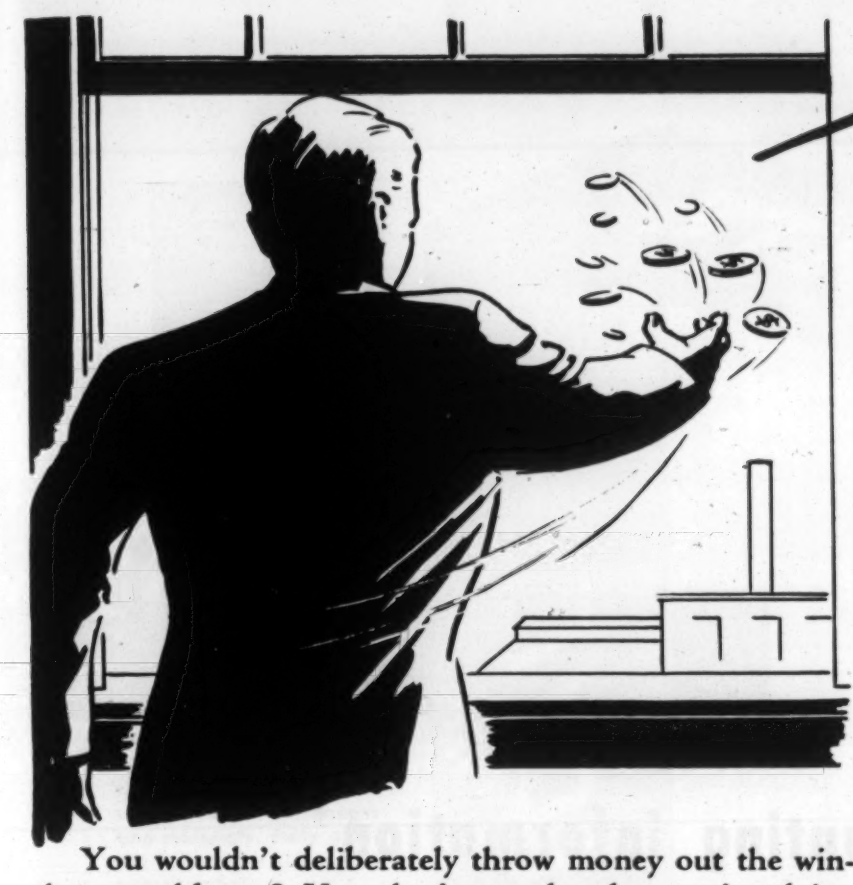

PICTURE OF A FOUNDRY OWNER WHO STICKS TO *Old-Fashioned* CRUCIBLE FURNACES

You wouldn't deliberately throw money out the window, would you? Yet, that's exactly what you're doing if you hang onto old-style crucible furnaces when you could have the advantages of a Radiant top-fired furnace, at no cost. This new crucible melting furnace will pay for itself the first year! It's revolutionary...and better...because it has *two* crucibles, loaded at all times. They are fired alternately; while the first crucible is heated, the flue gases from it preheat the second crucible. While the metal from the first crucible is being poured, a third crucible replaces the removed crucible to receive cold metal. The covers are cam lifted and swung backward independent of one another, so that each side is fired alternately. With this fuel-saving, faster-heating furnace available, you can't afford to use the older type any longer! Write today for further information.

The revolutionary Radiant furnace can be fired with gas or oil in tandem. Both stationary and tilting types are available. (Patents Pending.)

Scrap your old furnaces at *A Profit*—Here are 18 reasons:

1. 25 to 30% fuel saved on aluminum and magnesium. 40 to 50% fuel saved on brass and copper.
2. 50 to 100% longer pot life.
3. 50 to 100% longer lining life.
4. 50 to 100% longer cover life.
5. 50 to 100% longer burner life.
6. Easy to charge. (No flame through cover)
7. Far lower metal loss. (Flame does not impinge on metal)
8. Faster heating. (Combined radiant and convection heating)
9. Less slagging. (Less slagging and no slag build up possible)
10. Lining is easy to replace. (No burner ports)
11. Burners easy to inspect and replace. (Change in 15 minutes)
12. Burners cannot plug. (Burners in top where slag or metal cannot reach them)
13. Pure metal. (Neutral pressure on metal surface allows charcoal or atmosphere to be used)
14. Furnace can be flued through the floor to the outside, eliminating heat and gases in foundry.
15. No leakage of cover. (No flame through or around cover)
16. Quiet operation.
17. Unobstructed flueing. (Flued at bottom and charge does not affect it)
18. Metal is visible at all times and temperature can be taken at any time, without shutting off burners.

RADIANT COMBUSTION, Inc.

BUILDERS OF EVERY TYPE (OIL, GAS, ELECTRIC) OF HEAT TREATING FURNACE

WARREN . . OHIO

RADIANT COMBUSTION, Inc.
WARREN . . OHIO

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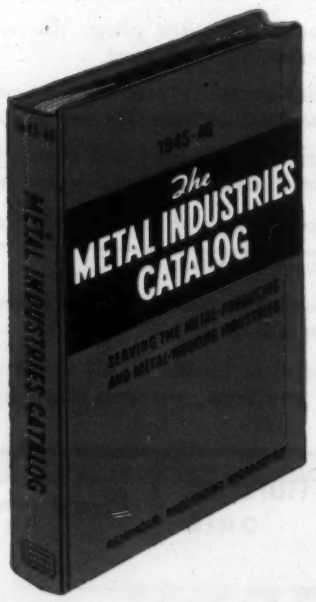

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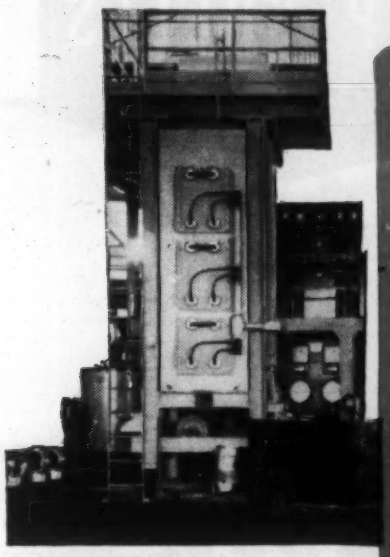


These furnaces produce clean, bright strip in continuous sequence, in the widest range of gauges and materials. Fully automatic temperature and speed control.

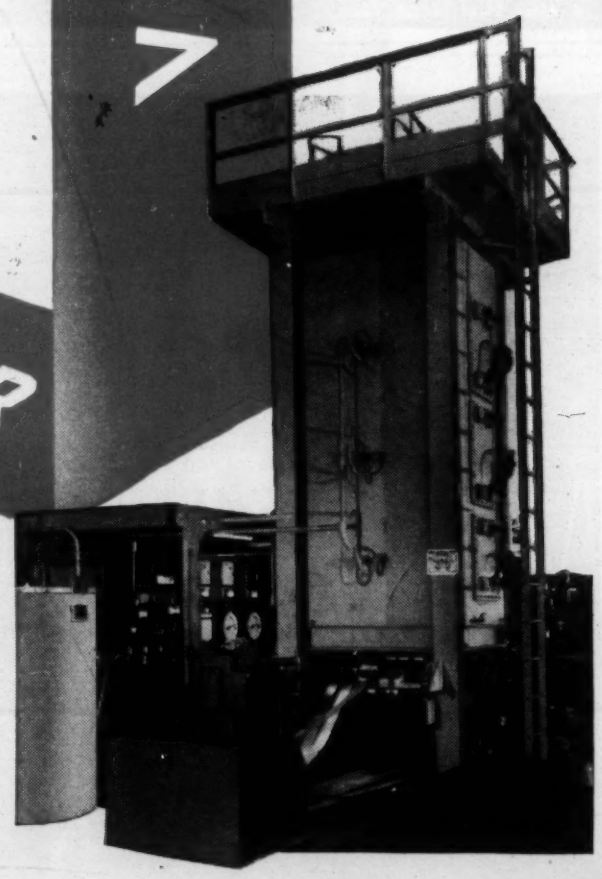
EXCEPTIONAL PRODUCTION QUALITY AND SPEED ACCOMPLISHED ON ANNEALED STRIP

1. Versatility and Flexibility of Production.
2. High Quality of Bright Anneal or Open Anneal.
3. Assured Freedom from Scratches, Blemishes or Other Surface Defects.
4. Minimum Floor and Storage Space.
5. Economical, Efficient Operation.

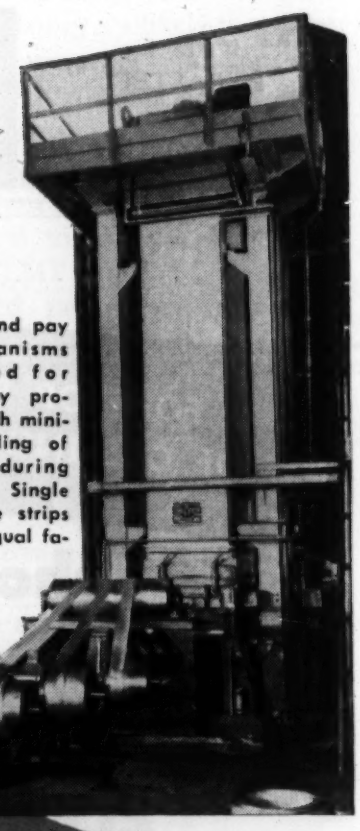
Feel free to investigate thoroughly the revolutionary advances inherent in this Drever furnace design which may be adapted to many production lines in any size or capacity range.

VERTICAL STRIP ANNEALING

DREVER FURNACES



The capacity of these furnaces range from a few pounds per hour to several tons per hour depending upon material and gauge being run. Ideal annealing atmosphere supplied by Drever Ammonia Dissociator (shown at left of furnace).



Take up and pay off mechanisms perfected for quick, easy production with minimum handling of material during processing. Single or multiple strips run with equal facility.

EXPERIENCE POINTS TO THE DREVER CO.

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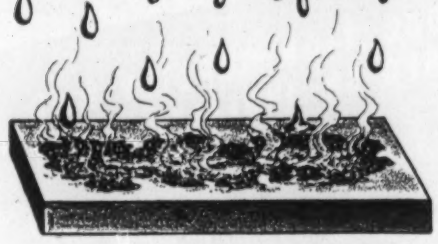
ACIDS . . . resisted by PYRASTEEL PUMP SHELLS

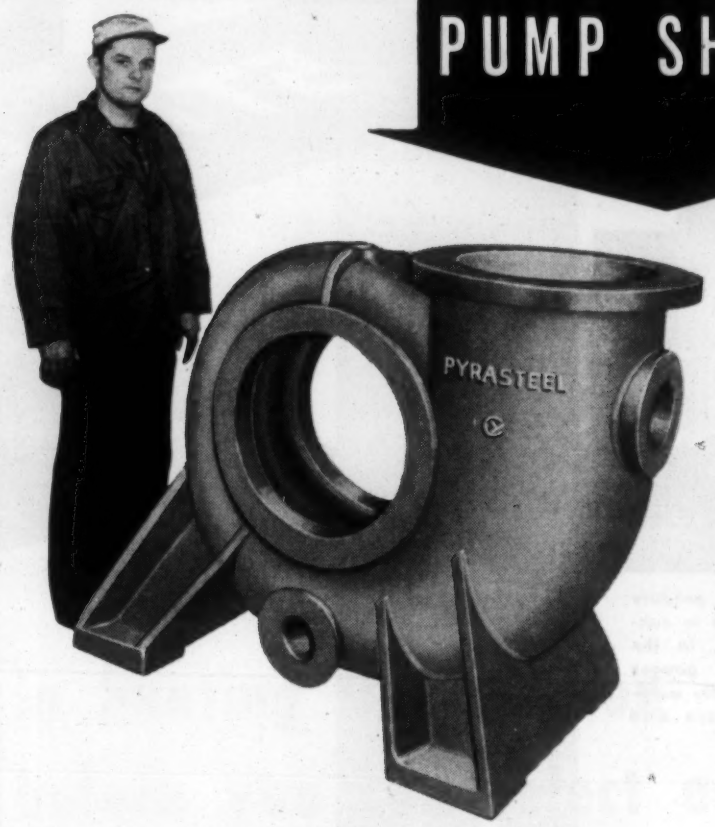


. . . corrode ordinary metal

PYRASTEEL is a pioneer corrosion-and-heat-resisting alloy widely employed because it provides maximum resistance to concentrated or dilute commercial acids and corrosive gases.

In high-temperature applications, PYRASTEEL also affords excellent resisting qualities at temperatures up to 2000° F.

It insures long service life at low cost in such diversified applications as furnace parts, conveyor screws, food and chemical processing equipment, and refinery fittings.



PYRASTEEL Pump Shell Casing —a mainstay of continuous service in acid-producing plants.

Write for PYRASTEEL Bulletin

CHICAGO STEEL FOUNDRY COMPANY

PYRASTEEL for high temperatures

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Makers of Alloy Steel for 30 Years

EVANSTEEL for strength

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Effective gantry design combined with platform attached to furnace for minimum maintenance and maximum efficiency of operation.

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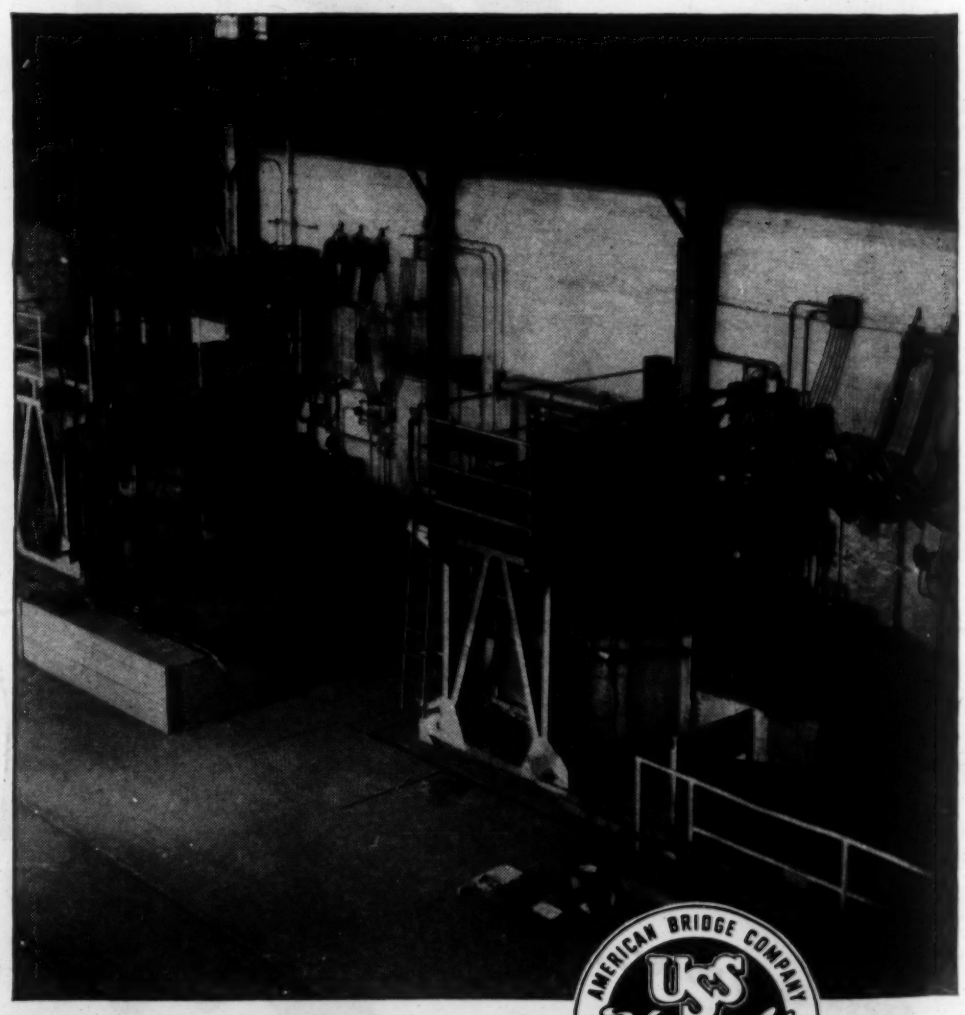


UNITED STATES STEEL

WHEN

NORMALIZING CYCLES PULL VARIABLE LOADS ON THE ATMOSPHERE GENERATOR

REAL CLEAN ANNEALING OF BRASS STRIP COULD SAVE FINISHING LABOR

YOU WANT DRY ATMOSPHERES UNDER YOUR ANNEALING COVERS

THEN

KEMP "atmos gas" can be tailored to your process

The atmosphere gas generator you use should be *tailored* both to your process and to your procedure.

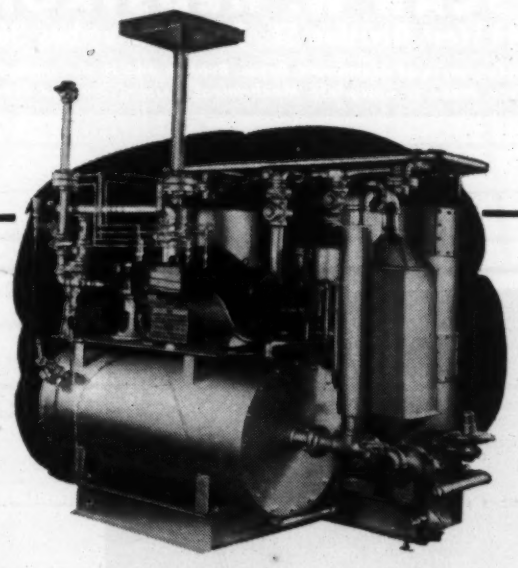
If you have a line of furnaces to be supplied by one generator (as in propeller blade normalizing) it's likely that your atmosphere requirement will be fluctuating—and you will want a generating unit which is equally efficient at 20% and 100% load—like a KEMP design.

If your process is continuous and your demand is high (as in brass strip annealing) you will want a unit which produces "atmos gas" at such low cost as 8 to 15¢ per M cu. ft. (amortization included)—which KEMP can do.

If water vapor must be removed (as in long-cycle high-temperature work) you will want a generator equipped with silica gel desiccating towers—such as KEMP engineers often build into a system.

If you want the CO_2 scrubbed out of the gas, or completely automatic operation, or special ignition devices, or all sulfur removed, or direct-reading flow indication—or other features which *tailor the job to your specific case*—then you're talking KEMP practices.

The coupon below will make it easy to get the full story.



A RECENT 2,000 CFH JOB ON STEEL WIRE HARDENING

This one (size 2MSG) has generous silica gel drying towers, orifice meters to indicate fuel and air flow, ample water-jacketed refractory-lined combustion chamber, elevated air filter, and the most precise and automatic type of carburetion obtainable. It feeds both muffle and radiant-tube furnaces in the 1400-1700°F range, by means of which steel wire (0.50 to 1.20 carbon) is heated for hardening—free from scale and decarburization—right up to the oil quench.

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ATMOSPHERE GENERATION & ADSORPTIVE DRYER SYSTEMS FOR PROCESS CONTROL AND PROTECTION

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I'll write and state my problem, so that you can talk my specific case when you reply ☐
Send your nearest field-engineer to see me ☐

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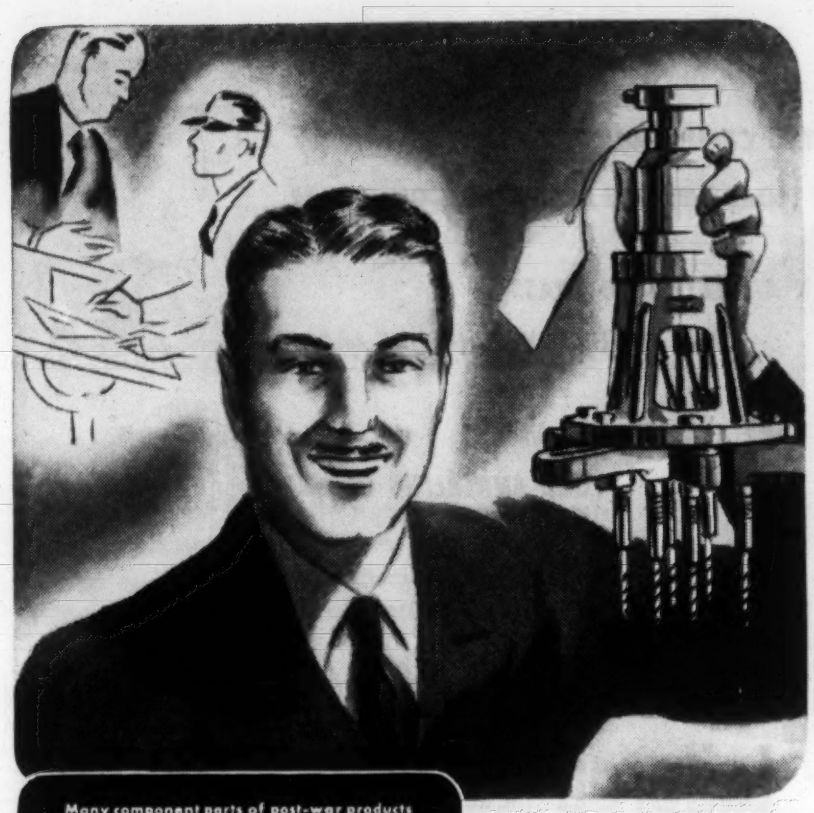

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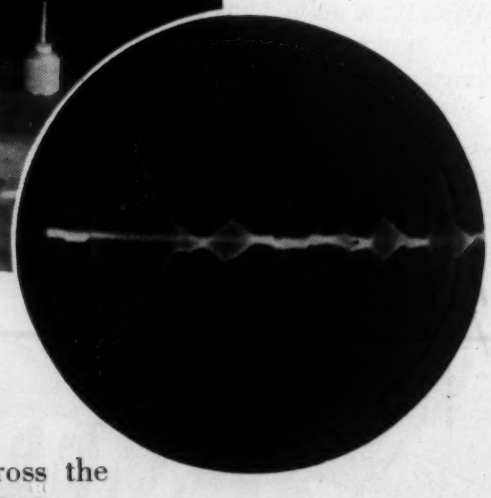
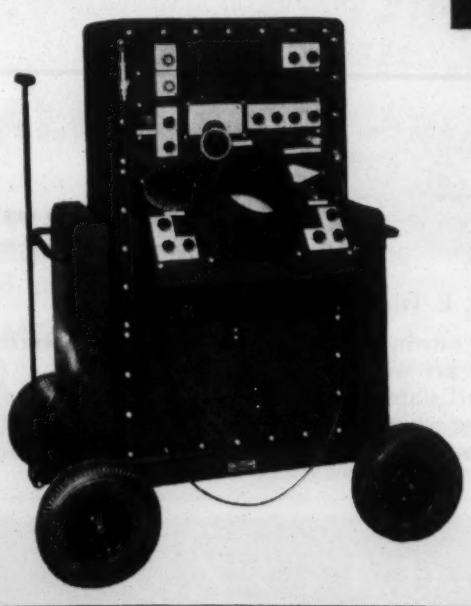
METAL TESTING

with

SUPERSONICS

The operator coats the surface of the material under test with a light film of oil, applies the searching unit, and watches the oscilloscope screen for evidence of internal defects. Total testing time requires only a few minutes.





A Portrait of Economy

To the right — a wave of light across the oscilloscope screen of the Supersonic Reflectoscope reveals the hidden defects. Quality of the production output is assured, no hours need be lost machining defective material.

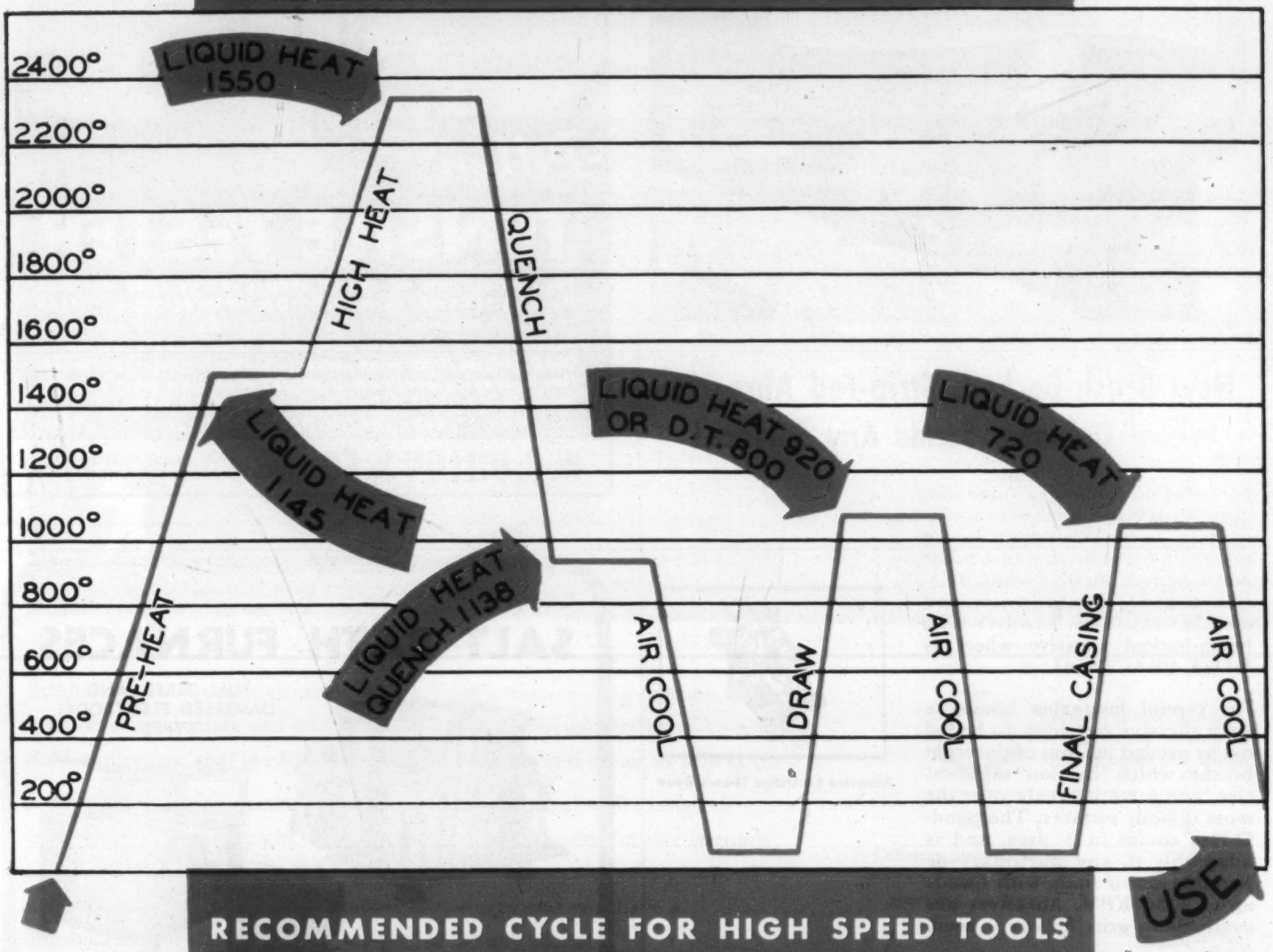
This new, outstanding instrument penetrates metals to a depth in the order of *ten feet*, accurately locates the internal defects. For complete information about the Supersonic Reflectoscope write for Bulletin L-3000.

SPERRY PRODUCTS, Inc. **Hoboken, N. J.**

FOLLOW THE RED LINE

FOR HIGH SPEED STEEL

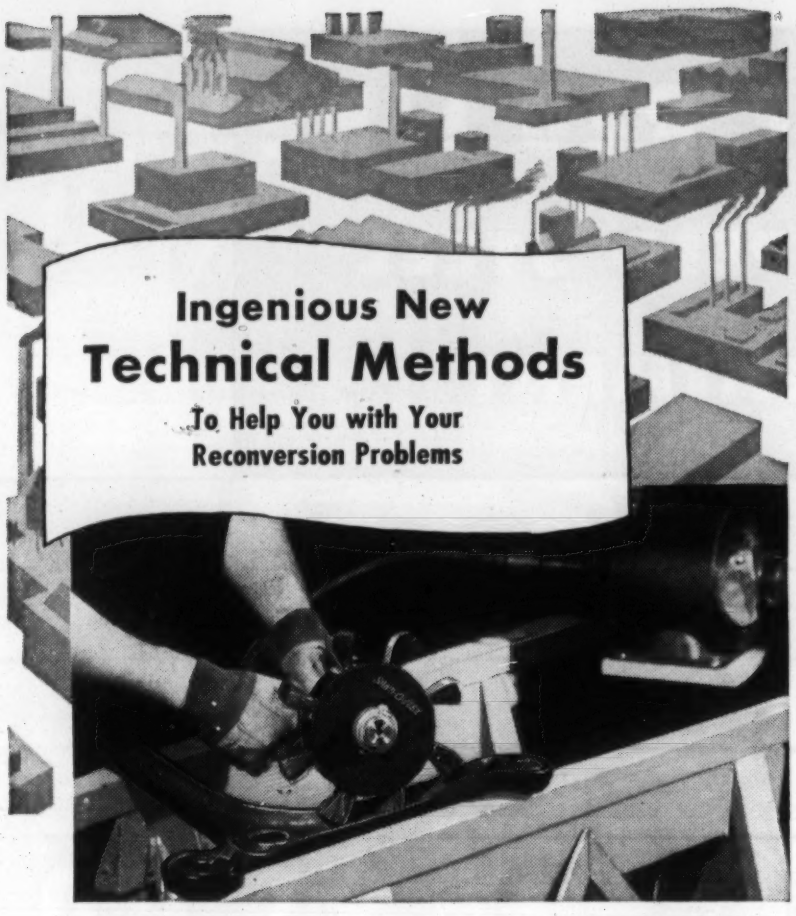
HEAT TREATMENT



RECOMMENDED CYCLE FOR HIGH SPEED TOOLS

New Houghton salts developed for heat treatment of high speed steels include Liquid Heat 1145, inhibited against decarb; Liquid Heat 1550, employing immersed graphite rod for automatic rectification, and Liquid Heat Quench 1138, usable at lower temperatures than former quenching salt. To these may be added a draw, and a final casing which lengthens tool life. For leaflets or for specific recommendations, write E. F. HOUGHTON & CO., 303 W. Lehigh Ave., Philadelphia 33, Pa.

HOUGHTON'S *Liquid* **SALT BATHS**



New Brush-Backed, Strip-Fed Abrasive Wheel Deburrs, Sands Any Surface!

For sanding in and around the most irregular contours—for deburring parts too large to be tumbled—for removing rust, paint and imperfections from wood, plastics, rubber, earthenware and metals—the new Sand-O-Flex brush-backed abrasive wheel is MOST PRACTICAL.

Abrasive Cartridge Shown Open

The central magazine houses a strip abrasive cartridge, to be fed out as needed in front of the eight brushes which "cushion" the abrasive, and force it evenly over the most difficult surfaces. The Sand-O-Flex comes in 3 sizes, and is adaptable to any stationary or portable motor shaft, with speeds up to 1750 RPM. Abrasives are available in grits for every need.

To help speed production in dry, dusty work atmosphere, many mills and factories urge workers to chew gum to help relieve dry throat. *The reason:* Because dust causes throat irritation and dryness—but chewing Wrigley's Spearmint gum helps keep workers' mouths moist and fresh. *The result:* Reduced work interruptions and "time outs" to the drinking fountain. Even when workers' hands are busy, they can refresh as they work "on the job." And the chewing action helps keep workers alert and wide-awake.

You can get complete information from the Sand-O-Flex Corporation, 4373 Melrose Ave., Los Angeles 27, Cal.

AA-74

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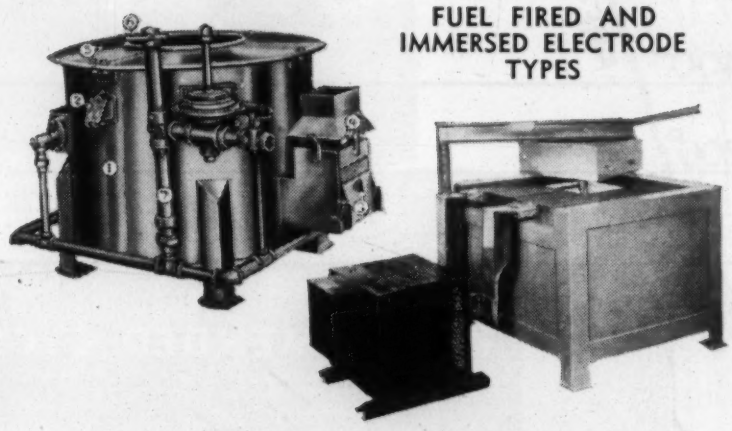
SALT BATH FURNACES

FUEL FIRED AND IMMERSED ELECTRODE TYPES



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Over 20 standard sizes or built to meet your needs. Note convenient lighting and observation port. Accessible clean-out. Ventilated stack connection . . . keeps useful heat inside furnace. Single valve operation.

Immersed Electrode Type

27 standard sizes. Temp. range from 400°-2400°. With or without conveyors for continuous Salt Bath Heat Treatment and Quench.

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FURNACES: Gas-Electric-Oil-"TAILORED" by DEMPSEY Meet every Heat Treating Need

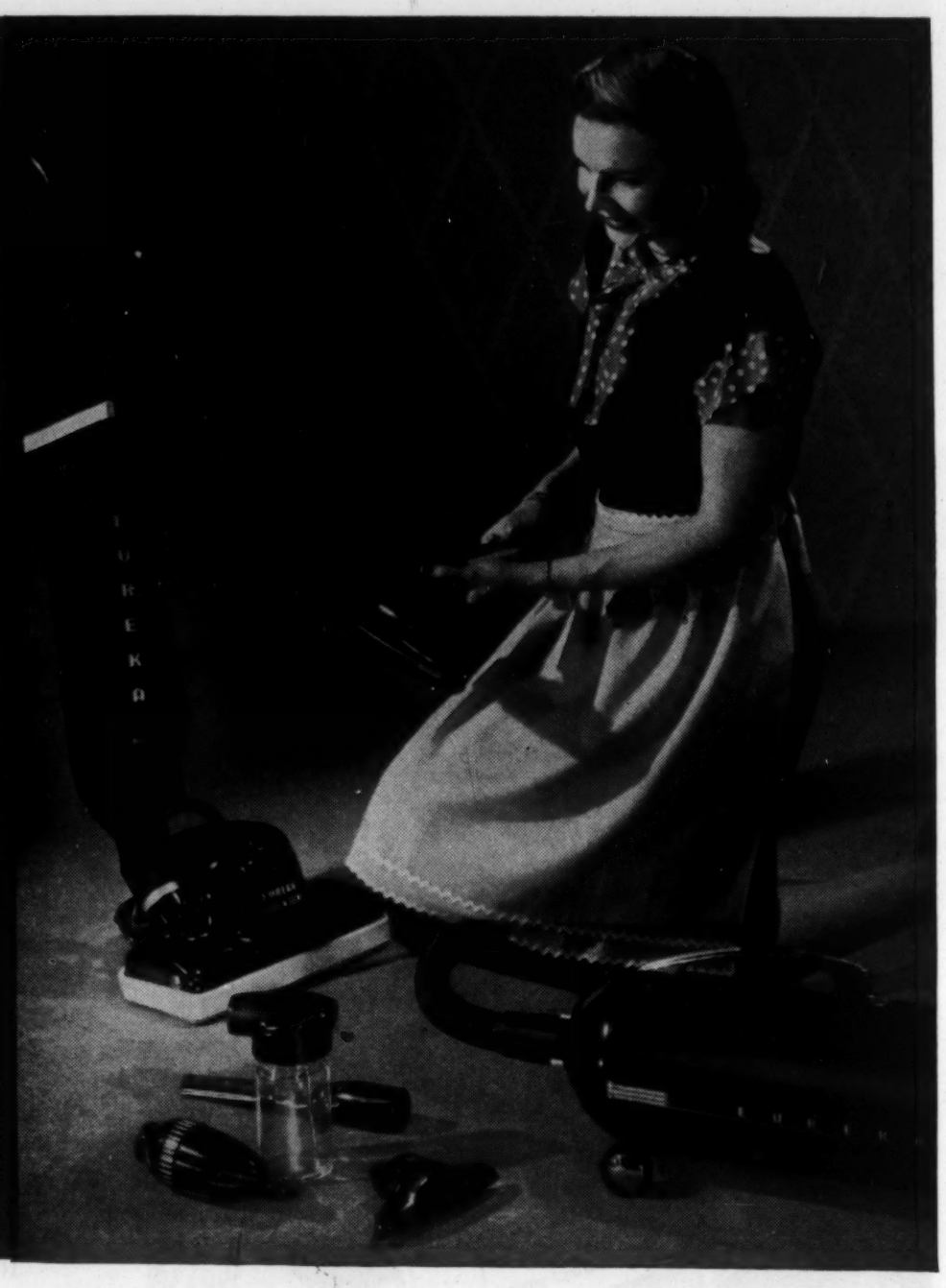
DEMPSEY FURNACE

DEMPSEY INDUSTRIAL FURNACE CORP.

Springfield 1, Mass.

TOUGHNESS TEAMS UP WITH COLOR

to lighten household chores



EUREKA's new vacuum cleaners, styled in an attractive deep maroon, show how cellulose acetate and ethyl cellulose help manufacturers to make household equipment that is easier to sell, easier to use, and easier to *keep* in use.

These three selling points stem from the cellulosics' wider range of colors, their lighter weight, and their unusual toughness, impact strength, and dimensional stability. Add the production economies of high-speed injection molding to these consumer advantages and you have a combination of characteristics unequalled by any plastic.

If *your* products need re-styling for greater salability and durability, why not investigate the cellulosics *now?*

Cellulose plastics combine color, toughness, washability, for lamp bases and shades

Cellulose plastics keep kitchen utensils colorful, sparkling, sanitary

Cellulose plastics bring new, enduring color-styling to bathroom fixtures

HERCULES

CELLULOSE ACETATE
CELLULOSE NITRATE
ETHYL CELLULOSE

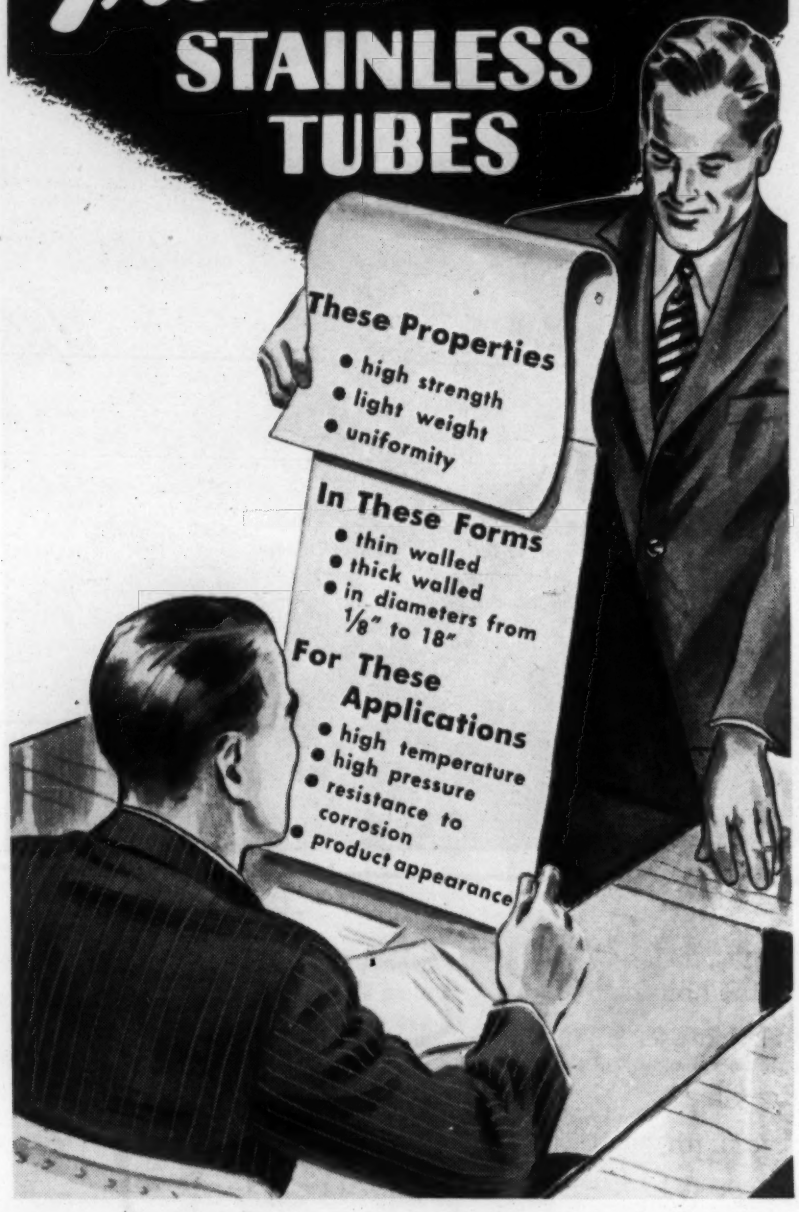
For general-purpose production plastics

Hercules does not make plastics or molding powder, but supplies the high-quality cellulose derivatives from which they are made. For data, please write

HERCULES POWDER COMPANY INCORPORATED 907 Market Street, Wilmington 99, Delaware.

CP-88

Have you a *cost reducing job* for *Trentweld* STAINLESS TUBES



PACKING great strength into lightness in weight, Trentweld stainless tubes have been developed to stand up longer under the most difficult conditions of service. They deliver superior performance because Trentweld methods of rolling welding and finishing are original and singular.

These better tubes, in stainless steel or Inconel, can be economically produced to meet your exact requirements; made-to-order in large or small quantities to fit your specific need for processing or maintenance work. Compare the service record and satisfaction Trentweld tubes will give you against the experience to which you are now accustomed. Without obligation, address Department 16 on applications you have in mind, or write for the Trentweld Data Bulletin.

TRENTWELD STAINLESS STEEL TUBES

Sales Office - 664 N. Michigan Ave.
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TRENT TUBE MFG. CO.
Mill at
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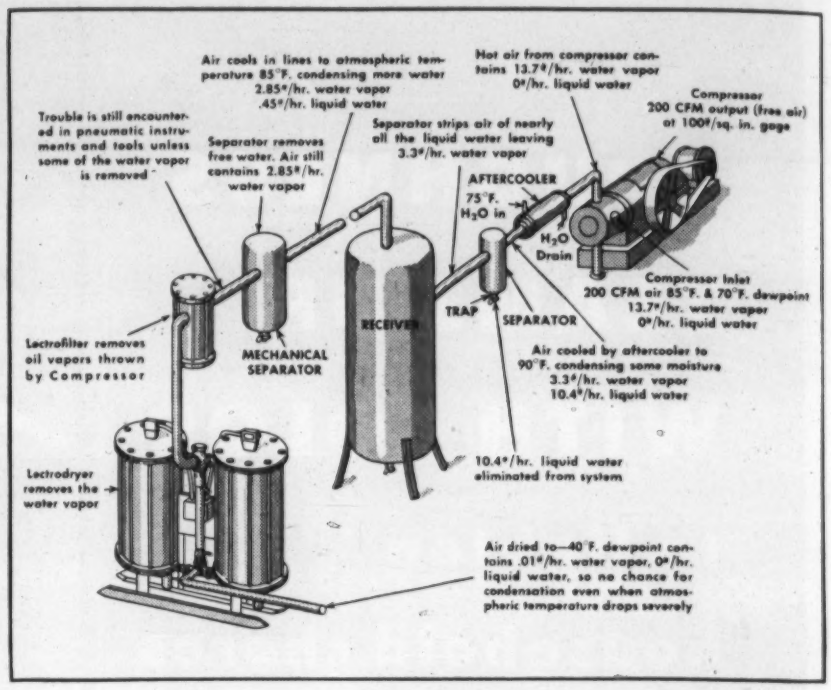

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MAKE or HEAT TREAT
any kind of TOOLS or DIES

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YOU'LL WANT TO KNOW

- how to select and heat treat the right tool steel for the job
- improve tool performance and cut costs
- save time and money in the toolroom
- the relation of design to heat treatment
- trouble shooting
- testing procedures

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Vice-President of
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315 *Pages* 205 *Illustrations*
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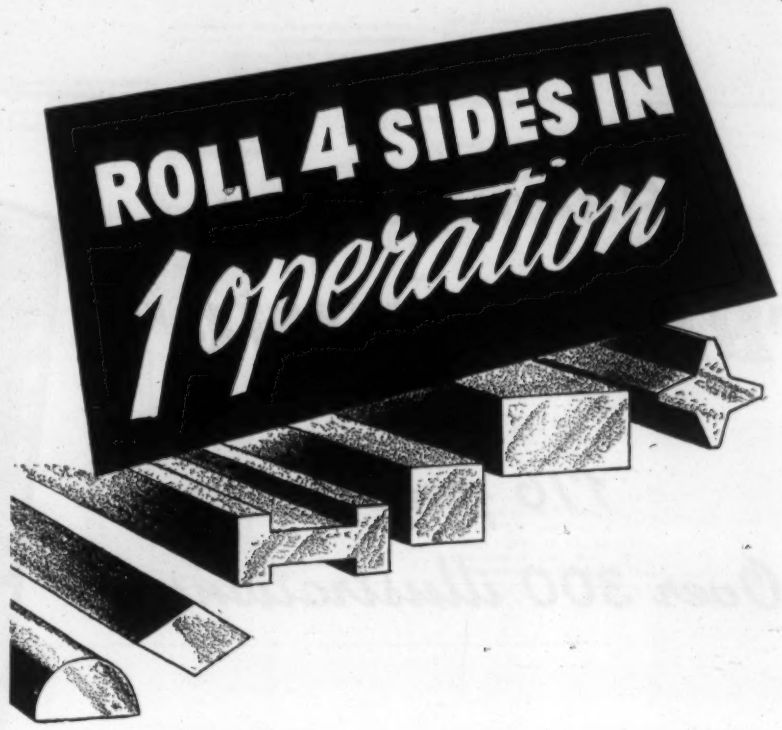

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"Standard" Turks Heads, universal and plain types, are available in a wide range of capacities.

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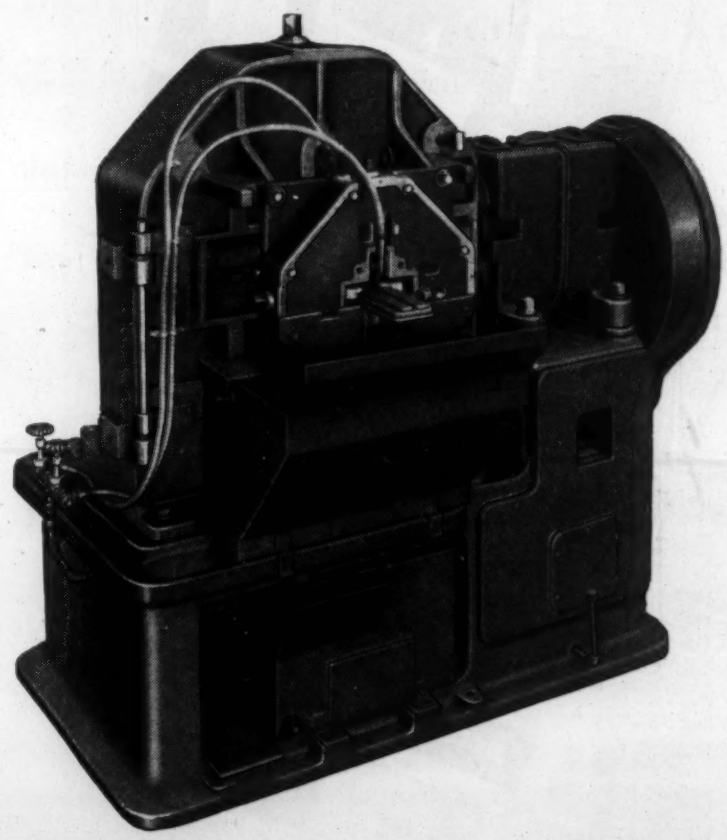

STANDARD MACHINERY COMPANY
1542 Elmwood Ave., Providence 7, R. I.

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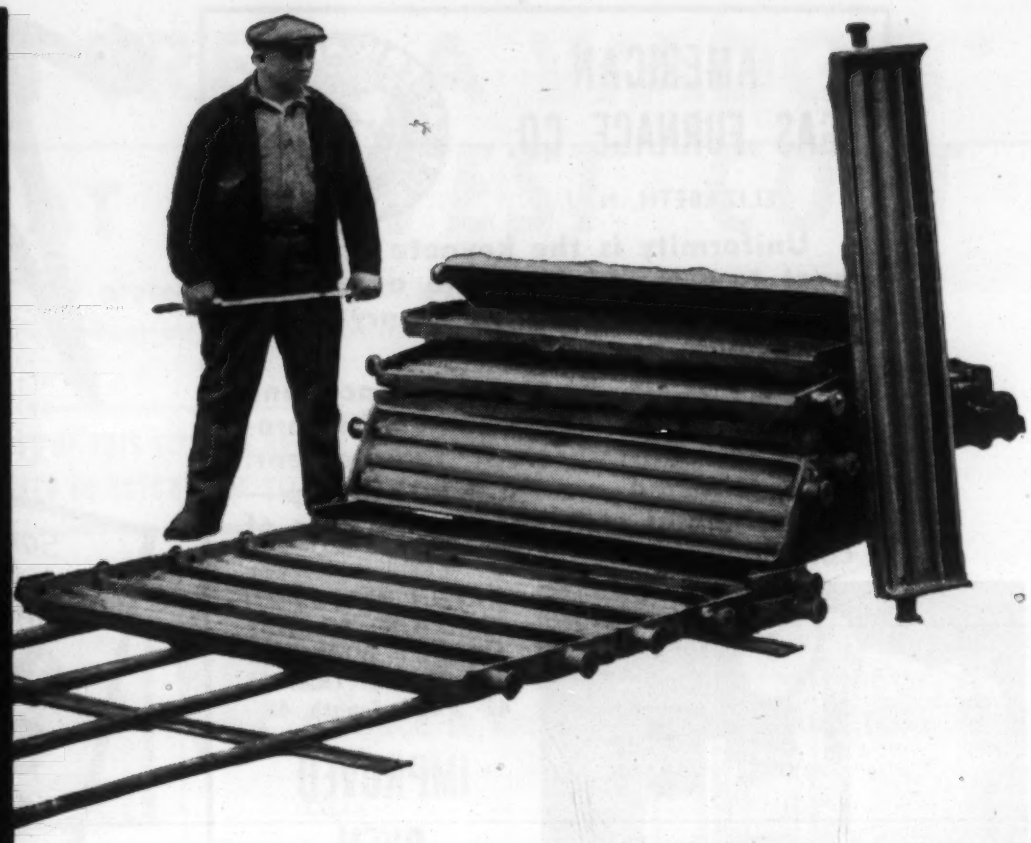
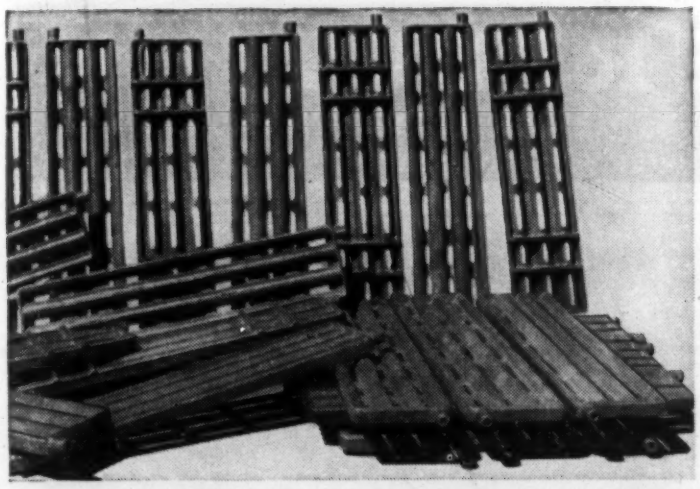
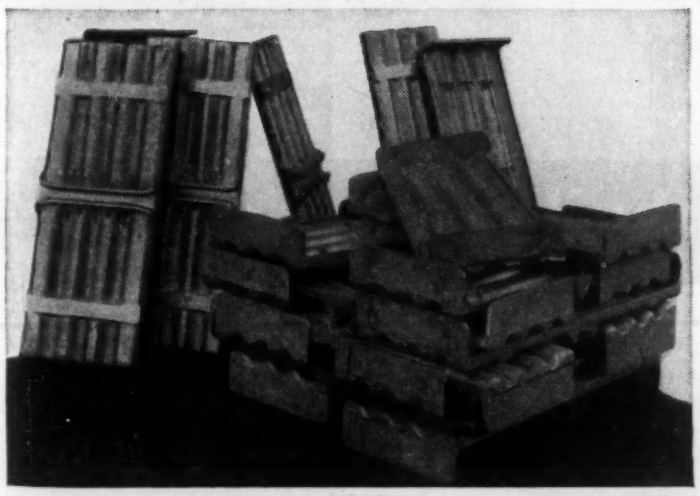
SKID RAILS AND CORRUGATED TRAYS

For Use in Pusher Type Furnaces







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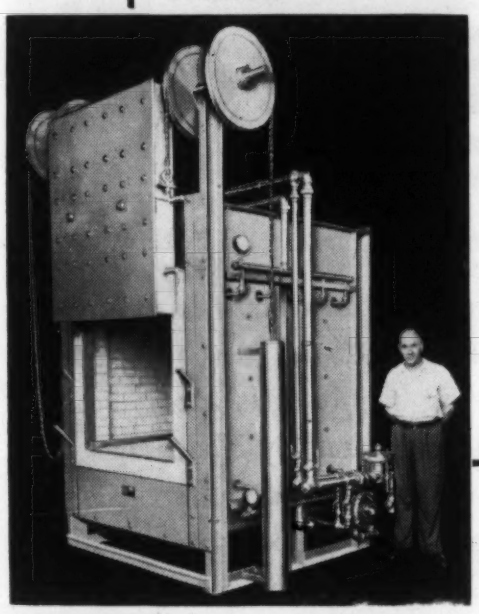

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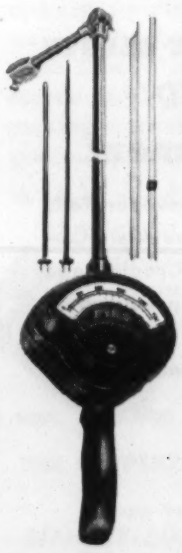

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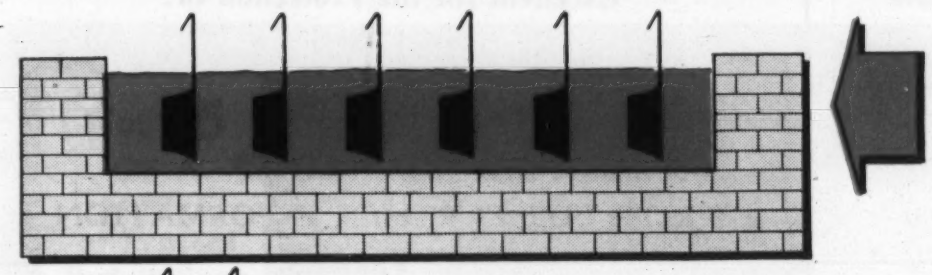
Manufactured by

GIBSON ELECTRIC COMPANY

8356 Frankstown Ave., Pittsburgh 21, Pa.

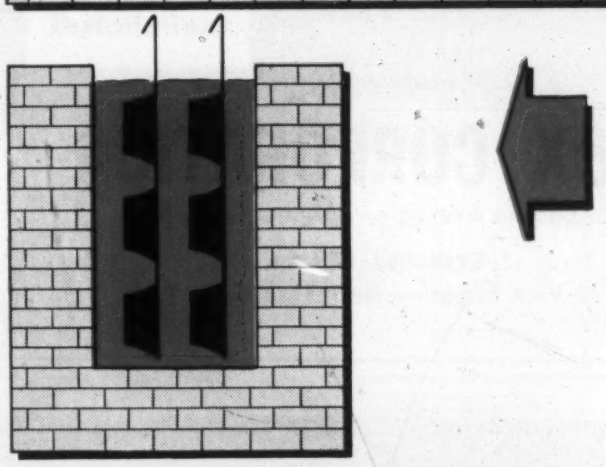
HOW TO HEAT TREAT A WADGET* AT LOWEST COST

To protect the surface, avoid distortion, eliminate decarburization, a salt bath furnace will, of course, be used



If you get a *conventional* salt bath furnace it looks somewhat like this . . . and the Wadgets are placed like this.

Note the surface area exposed†

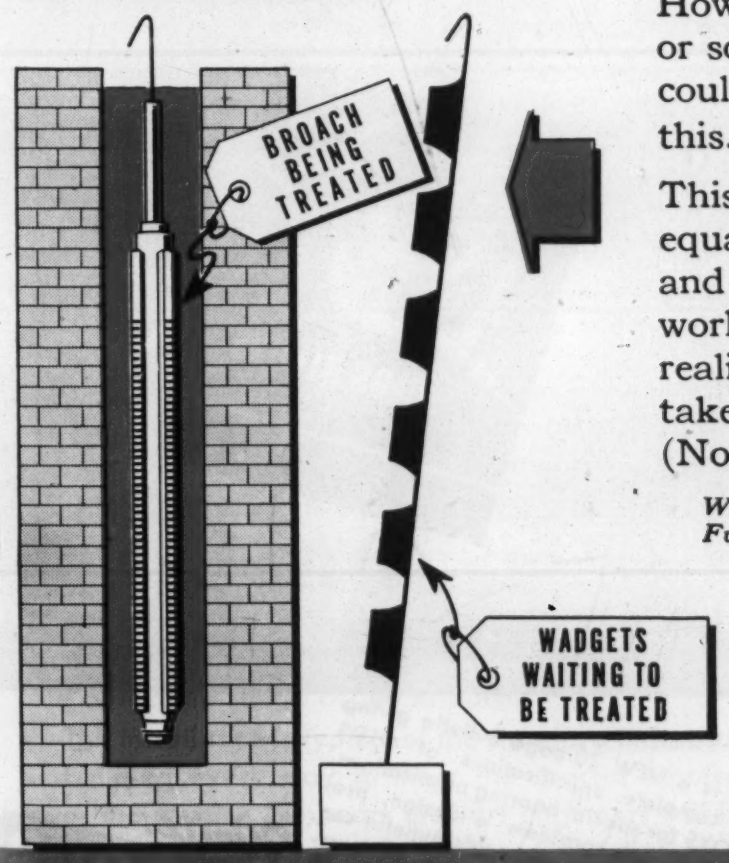


If you have an *Upton* Electric Salt Bath Furnace it would probably look like this . . . with the Wadgets being placed like this.

Note surface area exposed†

†Surface radiation losses equal 15 KW per sq. ft. per hour.

However, if you also wanted to treat a broach or some similar long piece of work, then you could use an Upton Furnace that looked like this.



This saves more heat (and more power), does equally good work, takes less time loading and unloading, but some people think it won't work; that it's too deep. So, until they do realize that Upton Furnaces can be built to take any length work, the other furnace (No. 2) is usually supplied.

Why don't you send for more information on Upton Furnaces? Send us the dimensions of your Wadgets.

* Wadget: A piece of work that you are wondering how to treat for better results and at lower cost than at present which will eventually be heat treated in an Upton Electric Salt Bath Furnace because there is no known size or shape that cannot conceivably be treated in an Upton Electric Salt Bath Furnace

Upton ELECTRIC FURNACE DIV.

7425 MELVILLE AT GREEN • DETROIT 17, MICHIGAN

Talk About PRODUCTION Without DIES!

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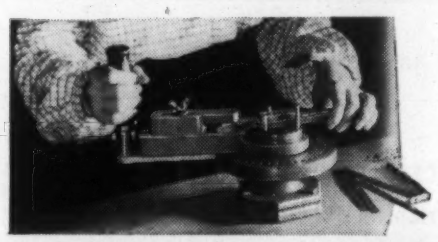

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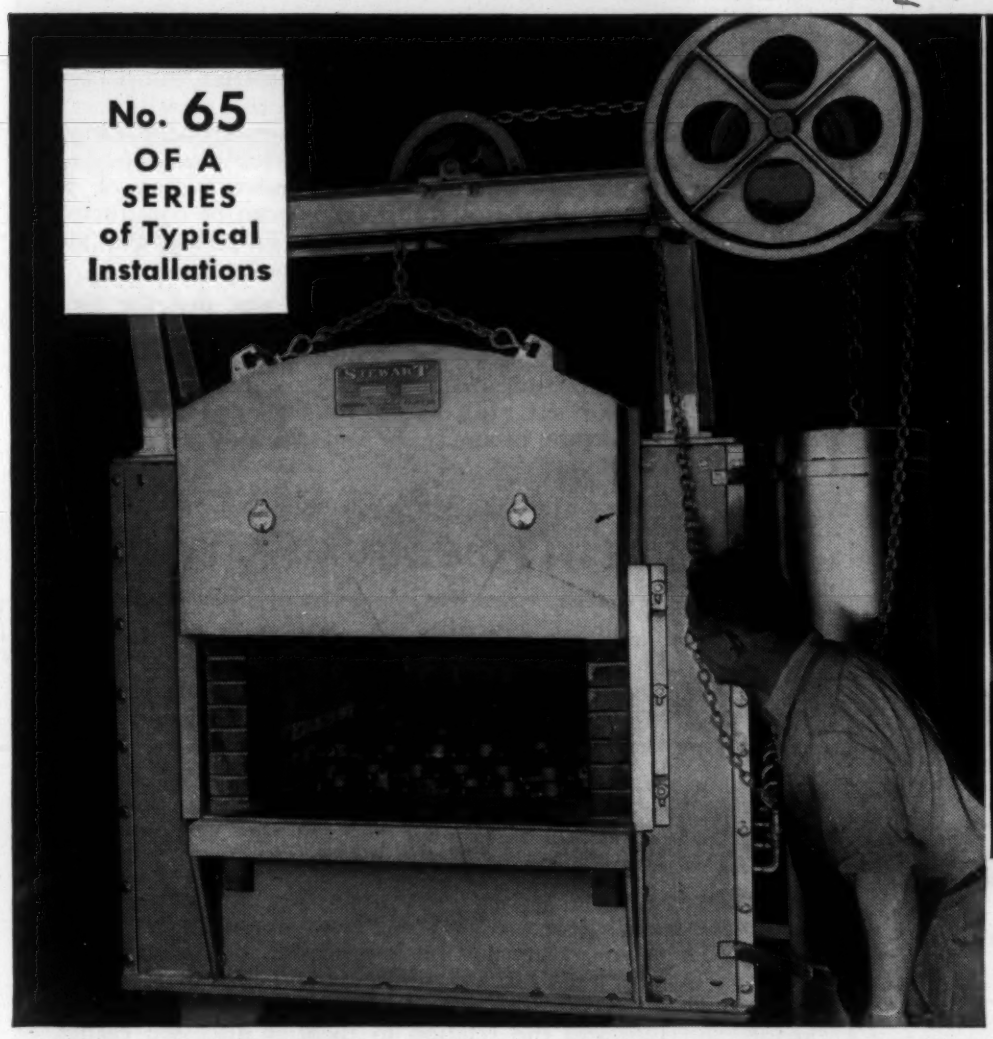

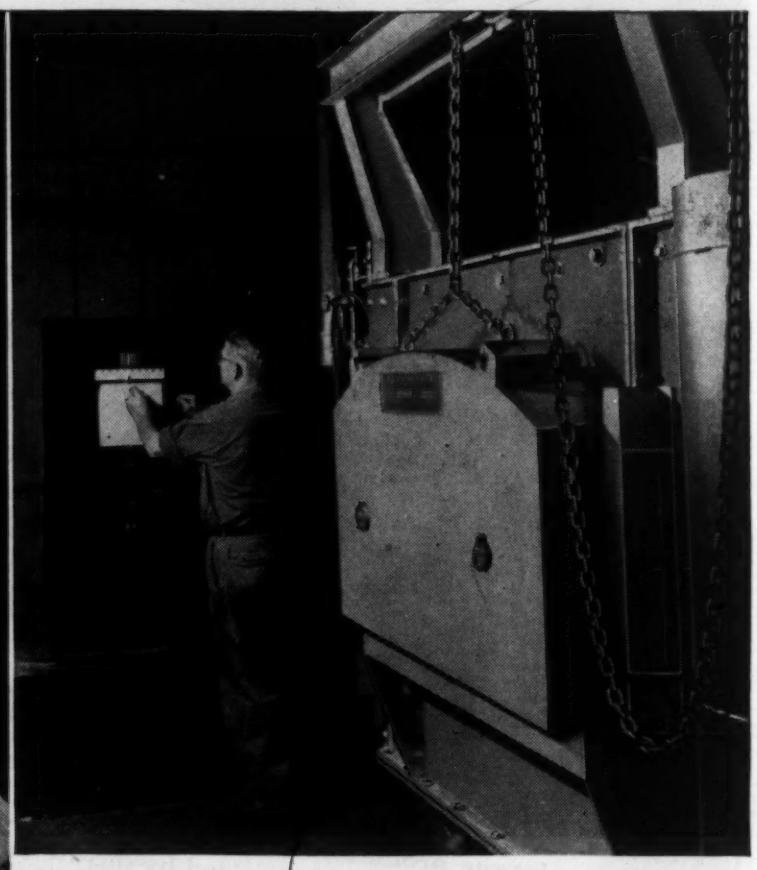

(At left) *Pump castings being normalized in large Sunbeam Stewart Oven Furnace. The control of atmosphere and temperature required is easily secured.*

(Above) *Checking temperature controller used in conjunction with Sunbeam Stewart large Oven Furnace. Consistency and uniformity of temperature is recorded on all work.*

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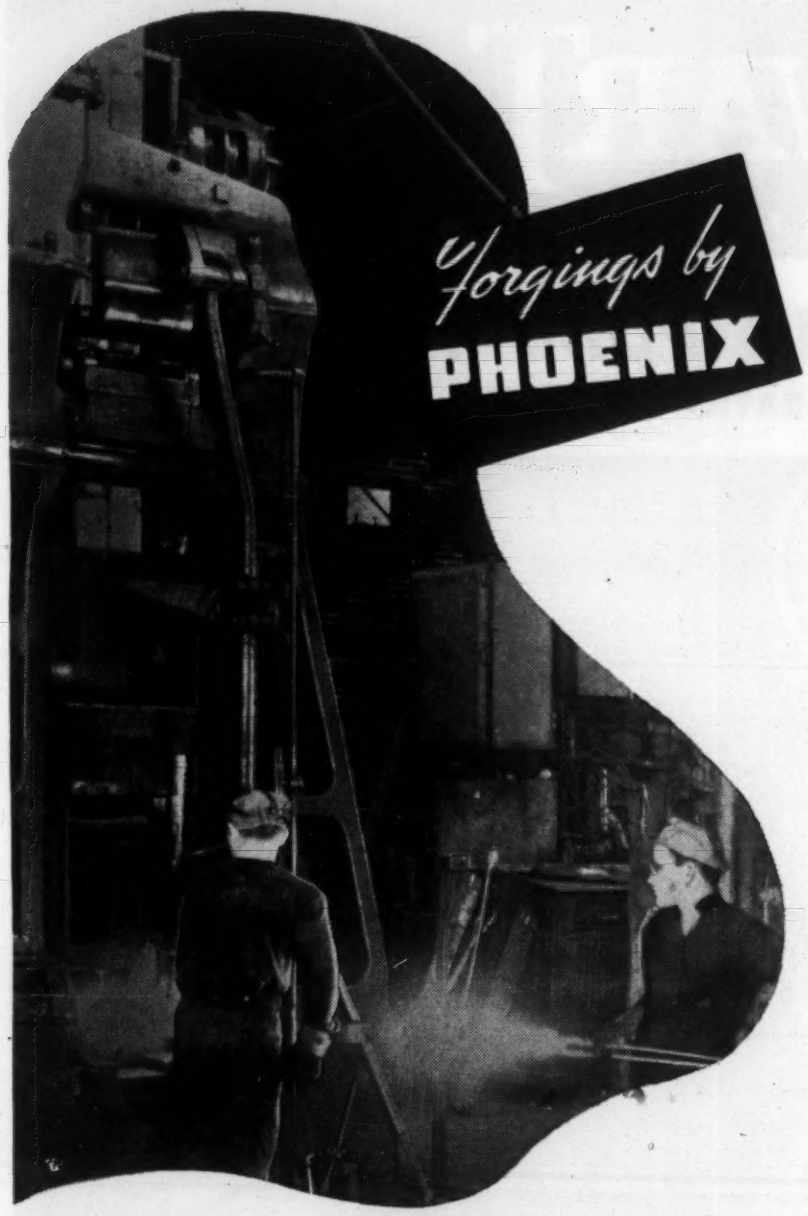

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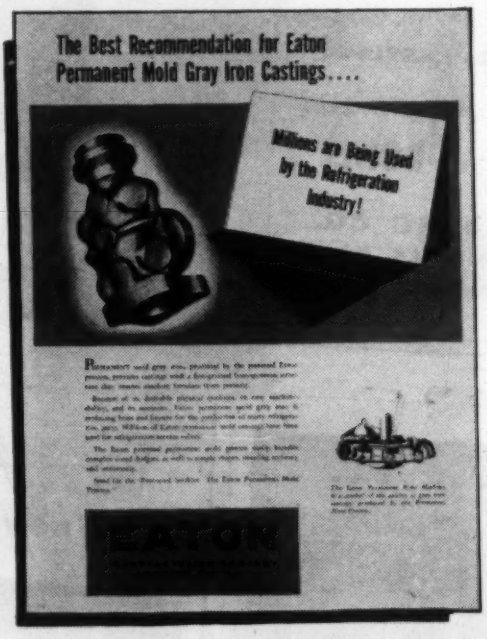

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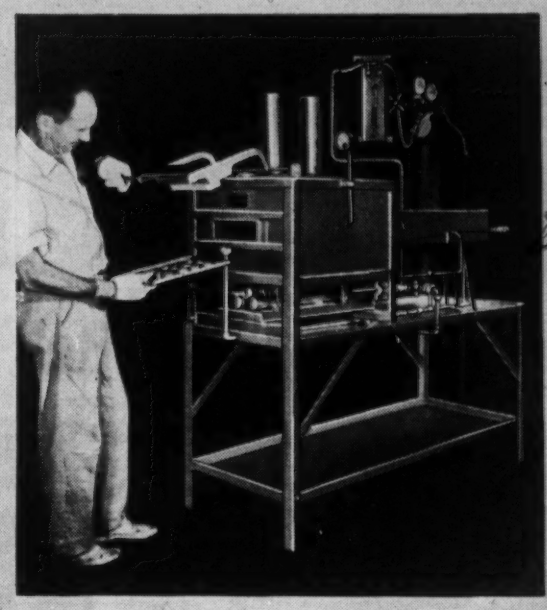

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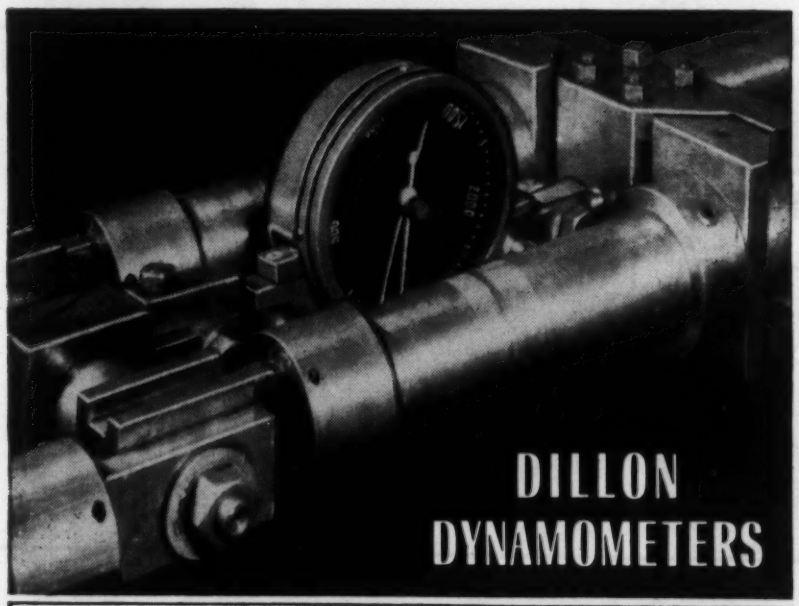

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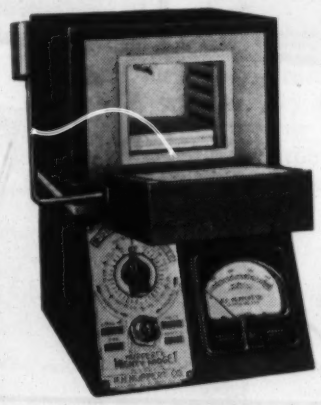

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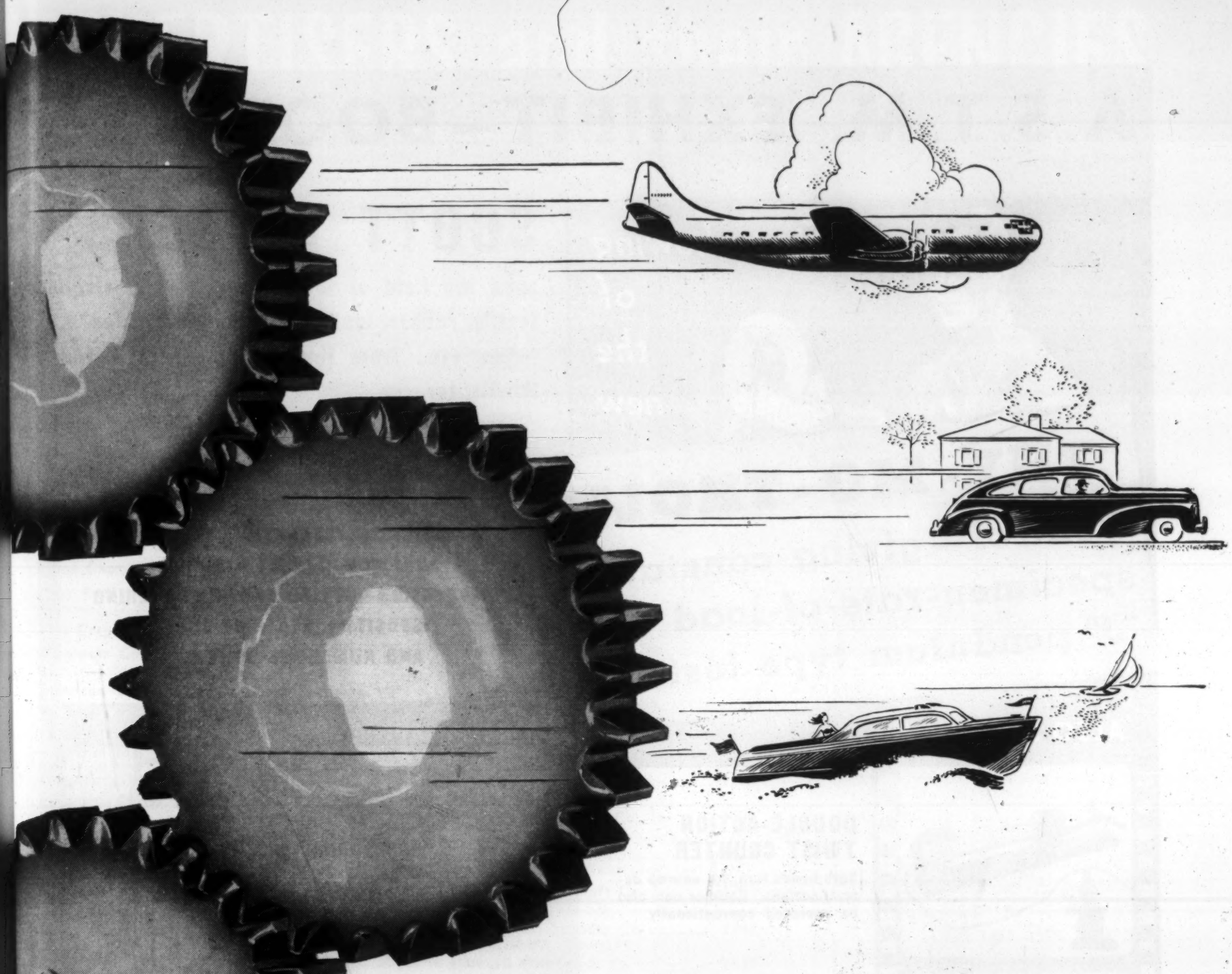

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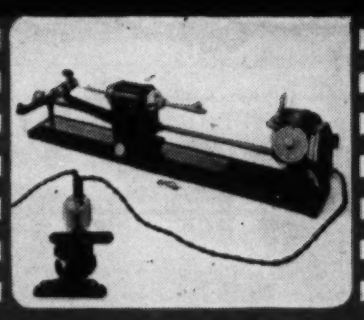

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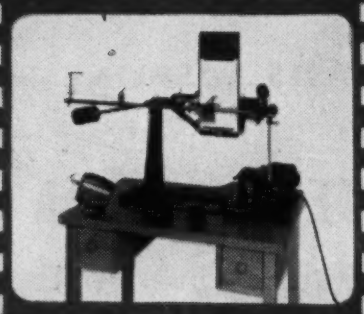

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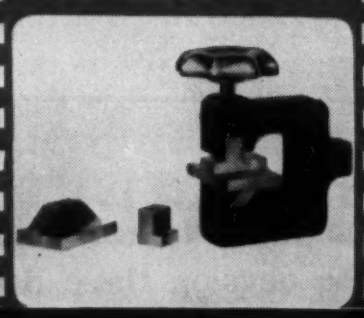

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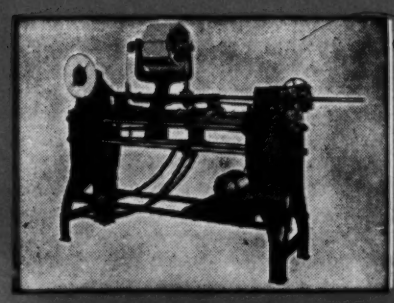

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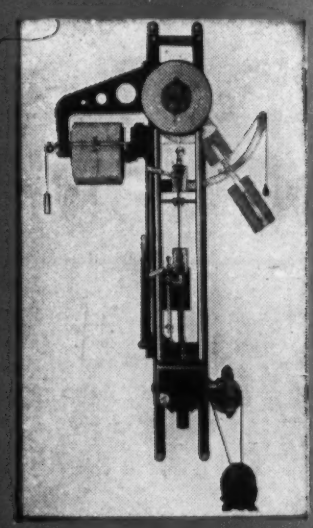

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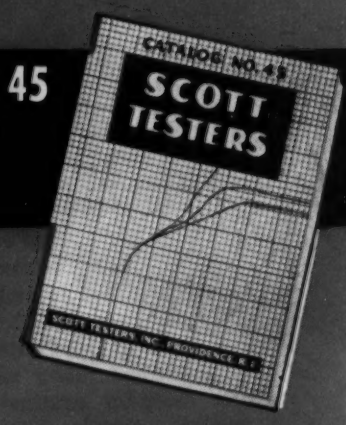

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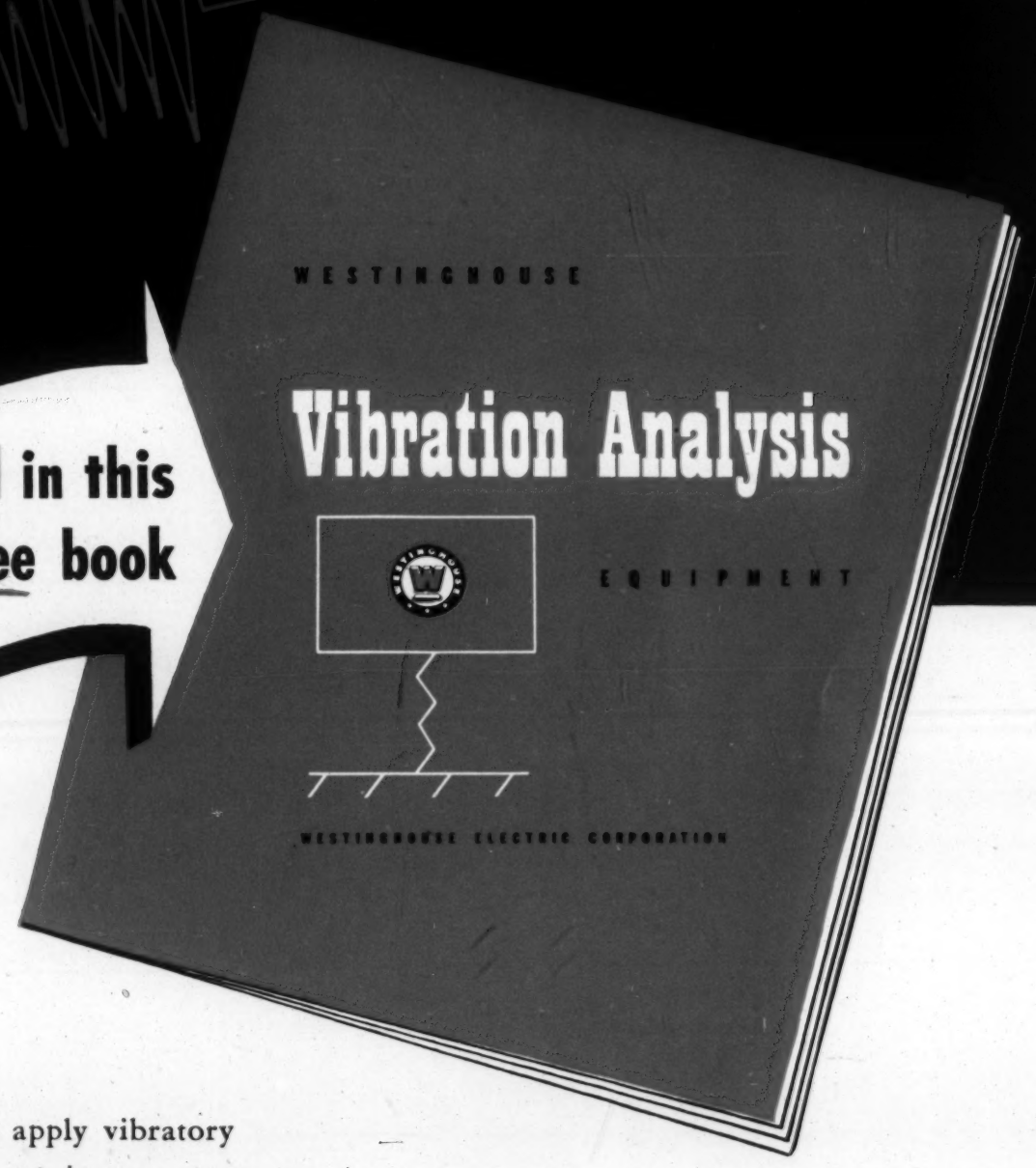

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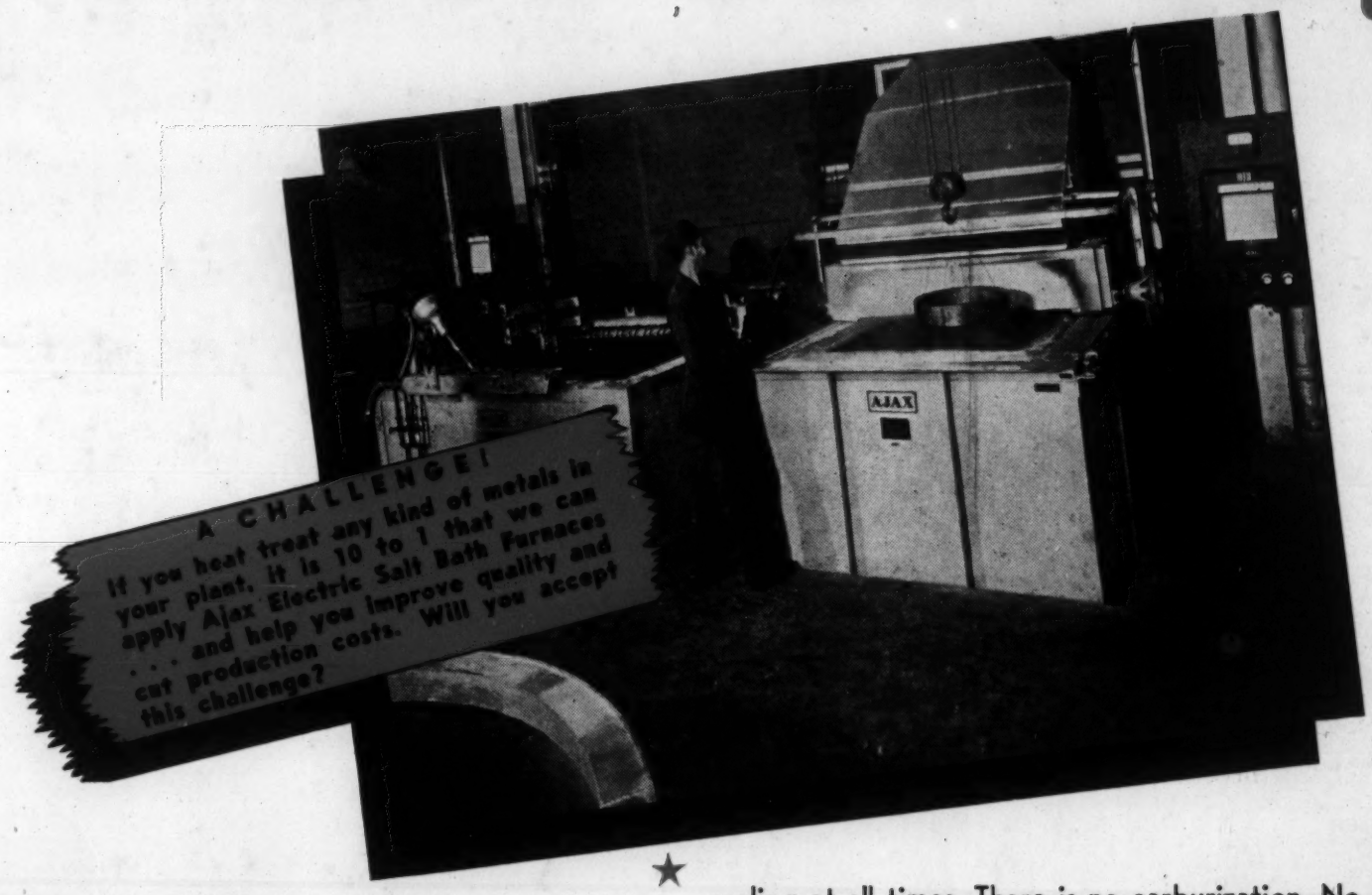

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